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MOTOR DEVELOPMENT IN MEN-OF-WAR.

THOSE who are conversant with the requirements of a modern man-of-war, and are likewise interested in the development of electrical science, must look forward to the day when that form of energy must be far more freely employed than heretofore.

The modern battleship consists, essentially, of the main boiler space which, in addition to the main engines, supplies energy for a hundred and one auxiliary purposes through long and tortuous transmissions to small, cramped, and often ill-ventilated spaces.

Economy of power for these purposes is not strictly considered, nor is first cost a matter of grave import. Economy of space and ease of transmission are the matters of greatest consequence. Surely here, if anywhere, therefore, electrical energy possesses an ideal field of application?

A slow process of acknowledgment of this fact is evidently at work at the Admiralty, but their action is half-hearted and perfunctory to such an extent as almost to suggest an enmity to electrical development; for it must be remembered that their present essays in this direction will be reported on, chiefly with regard to their practical efficiency, and errors of detail and design are more than likely to be interpreted into errors of principle.

Electric motors have so far been considered mainly in connection with a highly important operation—the supply of ammunition from the magazines to the larger guns, a subject which assumes ever increasing importance with the increasing rapidity of fire; the fitting of such motors has been cramped and confined to accommodate other sources of energy, to all of which it remains a mere after thought.

To stimulate interest in this important subject, it would be well to note, briefly, the points of the problem to be solved in this connection.

The primary requisite is an elevator capable of supplying at least one complete charge to a height of some 30 feet, the load, including cage, varying anywhere from 800 to 2,000 lbs. The principle should be a counter-balance, possibly of two supplying cages. The speed should be the greatest possible consistent with safety. No slow motion at starting or stopping is necessary, except in so far as the sudden strain on the rope, &c., may demand. It would be advantageous to have a fairly constant speed for varying loads.

The motor should be situate under protection, *i.e.*, low down, but controlled, for reversal or alteration of speed, from the top of the hoist shaft.

It should be of such a power as to ensure a fairly good efficiency when working with full loads. The gearing should of course be as frictionless as possible, and the motor and gearing should occupy the smallest possible space. The

electric circuit should be simple. The safeties should be such that by no possibility can the full cage descend through the bottom of the ship; such safeties must provide, therefore, for both failure of suspension rope and electric current.

There should be an automatic cut-off for retaining the cage in the positions of filling and clearing.

Having regard to such requirements, there will be found, as one of the latest developments of the motor system in this respect, a somewhat inadequate solution of the problem, a small series motor working, through a train of noisy untrimmed cogs and mitre wheels, an unbalanced cage, and controlled by a pawled brake.

The motor thus does as much work in lowering the empty cage against the brake, as in hoisting the full load.

The speed is considerably under that of the steam hoist, which it supplements.

The efficiency barely exceeds one-half (an excessive waste partly due to the gearing, but in part to the poor electrical efficiency of a small motor), so that to raise each charge, nearly six times the necessary power is expended in electrical energy.

The action of this brake, on which total reliance is placed for safety under certain conditions, is open to considerable criticism.

Attention is called to these facts, not from any desire to reflect on the contractors or others concerned, who probably labour under great limitations, but to show how heavily handicapped the motor system must be, and how far short of the possible noiseless, powerful and efficient motor, the naval service has fallen. There is little doubt that the electric motor must come, and come soon, in its best form for this and other auxiliary purposes on board a man-of-war, and naval officers will certainly welcome the day when there will be no far reaching and leaking steam pipes, no distant engines needing to be warmed through, or raising a noisy clatter when running.

Electrical Installation Rules.

In the multitude of councillors there may be wisdom, but we fear in electrical matters it more often than not leads to confusion. The desire for some standard electrical rules, which shall be recognised and accepted by all concerned, has long been felt, and freely expressed by those having to do with electrical work in this country; and, judging by our American contemporaries, the same want of some common understanding in the matter of rules and regulations is as keenly felt in the United States as here. There, indeed, their number is legion, for every corporation or association of fire underwriters, engineers, electricians, and architects—to say nothing of the numerous electric lighting concerns—issue their own rules for electric construction; and, as their interests are somewhat conflicting, it will be readily understood those rules differ materially in important points—to the utter bewilderment of the manufacturers of electrical fittings. We are, therefore, pleased to note that steps are now being taken by our American friends to put an end to this chaotic state of things by bringing together delegates of the leading interests concerned with the view to securing the adoption of a single set of standard rules. In this country matters have slumbered somewhat since the day when the battle of the rules was fought, and when much heat was evolved, but producing no amalgamation or fusion. In the meantime important changes have taken place in the methods of distribution of electrical energy. Three and five-wire systems have come to the fore, and there is a general tendency towards higher voltages among the advocates of continuous current supplies. Then, again, the opposition to the use of wood casing is gaining ground, and other methods of wiring are coming into vogue. Recognising these changes, the Institution of Electrical Engineers are revising their rules, and it is no exaggeration to say that great things are expected of them as a possible way out of our difficulties. Should those rules be thoroughly and adequately revised they may become generally recognised as a standard for all electrical wiring in this country, and we are not without hope that even the fire offices will sink their differences and fall into line with the rest, for, if not mistaken, they also are awaiting the advent of the new rules with much interest. Unfortunately there comes upon us at this moment, as it were, a bolt out of the blue. The Liverpool and London and Globe Insurance Company have favoured us with an advance copy of a new set of rules, together with a "poster" of "Suggestions for the Use of Electric Current for Lighting, Heating, Power and Other Purposes." There are in all 116 rules, with an appendix of tables and forms. To say the least, they are comprehensive, and the get-up is excellent. We notice also that they are copyright. On a future occasion we may have something to say about these rules; but at present we are more concerned with the effect this step is likely to have upon rival offices, for they are evidently an independent production, and a departure that leaves little hope for that much to be desired agreement among the fire insurance companies in matters electrical.

Draw-bar Pull of an Electrical Locomotive.

The *Western Electrician* publishes a diagram of the current curve and the draw-bar pull of the electric locomotive made for the Baltimore and Ohio Railroad by the General Electric Company. The draw-bar pull was determined for each ampere of current put into the locomotive by means of a dynamometer car borrowed from the Pennsylvania Railroad Company. This car was coupled in between the train and locomotive. Every car was accurately weighed and there were in the train 28 cars and two dead engines, aggregating 910 tons (tons of 2,000 lbs. we may suppose). The diagram shows that the maximum current was 1,740 amperes, and the maximum pull on the bar was 46,000 lbs., or about 50 lbs. per ton on an up grade of 8 per cent. (1 in 12½). At this maximum pull the velocity, if we read the diagram aright was 19·4 feet per two seconds, or about 6½ miles per hour. The maximum recorded speed is 16·5 feet per second, the curve being here a horizontal line by which time the draw-bar pull has dropped to about 20,400 lbs., and this curve also is horizontal the pull per ton being now about 22 lbs. per ton. The two curves cross at a draw-bar pull of 32,500 lbs. and a speed of 12·75 feet per second, the amperage being 1,265. The horse-power at this point is therefore about 750 actual, the recorded power for a brief interval having been as above 811, and the maximum power, that shown at a draw of 39,000 lbs, with a speed of 720 feet per minute, which implies a rate of 851 horse-power. We believe the rated power of the locomotive is 1,800. The records above are of course exclusive of the traction of the locomotive itself, being merely for the train. It appears as though the electric locomotive were likely to afford a ready means of testing tractive resistance on railroads. Once get the rating of the locomotive itself and comparative results may be got without the dynagraph car, which will be a great advantage and will teach more of the mechanics of traction than many years of steam locomotive work has done, for the reason that dynagraph cars are scarce, and a steam locomotive is not easily indicated.

VIBRATION IN HIGH-SPEED ENGINES.

We have received a copy of the paper read before the North-East Coast Institution of Engineers, by Mr. J. M. Allan, on the subject of "Vibration in High-Speed Engines." Mr. Allan analyses all the movements produced by the different parts, and shows the effect with and without balance-weights, and he introduces an immense number of diagrams. He deals both with weights and steam pressures; in this we think he is quite wrong, as well as in treating the weight action so elaborately. We look on every properly constructed engine as a self-contained machine, so far as steam pressure action is concerned. All forces are restrained within the framing, and in respect of marine engines, force leaves the engine only in torsion of a revolving shaft, and, except so far as concerns the framing, steam stress may be neglected. It is mass which causes vibration. Strength of framing will not eliminate the effects of reciprocating or revolving masses. Any movement of mass will reappear outside the framing as vibration just as surely as the shifting of so many tons of coal will change the trim of the ship. Indeed, what is vibration but the attempt of something to take the place determined for it by gravity, the centre of gravity all the while shifting? As a matter of fact, the question of vibration is simplicity itself, and can be cured. Practically it resolves itself into how far it is convenient to take steps to cure vibration. Revolving masses can be balanced by equal and opposite equivalents. Reciprocating masses cannot be balanced by revolving balance weights. This is attempted in the locomotive, and is good enough on a solid track up to such a speed that the balance weight lifts the wheel off the rail. But the evil of the method becomes apparent on bridges which are not solid, and are set into dangerous vibration by locomotives. Mr. Yarrow advocated the system of bob weights for balancing reciprocating parts, which had been already shown to be only capable of such balancing by a previous writer. But there are certain practical difficulties even in balancing revolving weights. A revolving weight cannot be balanced except by an opposite weight in the same plane of revolution. Hence the tail crank placed as near the plane of crank pin revolution as possible. Correctly speaking, there are required three weights in any system of balance where the planes of revolution do not coincide. The crank pin is *in loco* of one weight; the crank tail is the second, and the third can be anywhere along the shaft, and on the same side as the crank pin. It is the crank tail really which is balanced by two other weights, of which one is the crank, and the other should be in the fly-wheel, their joint mass-radius equal to the crank tail, and their distance from the revolution plane of the crank tail inversely as their mass. Thus the crank tail has a mass of 100 lbs., centred at 1 foot radius. Then the crank pin mass should be 90 lbs. at unit radius, and revolving, say, 6 inches from the plane of the tail, and the secondary balance on the crank pin side of the crank should be 10 lbs., placed 54 inches from the tail. This would give perfect balance for revolving weights; practically perfect balance for the reciprocating parts on the crank pin, so far as the rectilinear movement is concerned; but there is introduced the unbalanced action of the balance weights themselves, and this points out how, for perfect balance, there must be bob weights. If there were not such a craze for cranks at right angles, the bob weights could be most easily applied in the form of pistons. Thus a three-line Willans engine, with two small extreme cylinders, and a heavier central engine with its crank at 180° from both the outer ones, would give the best possible balance in a practical engine. There would be no rock, except so far as the shortness of connecting rods caused some slight irregularity of piston movement. With cranks at 90°, the complications of balancing are much increased, and in stationary high speed engines the 90° angle is quite unnecessary. It is unnecessary at sea also. It is unnecessary in high speed locomotives, which are the only locomotives where balance is very important, but builders of steam engines are so wedded to precedent, that they seem unable to see anything outside its narrow lines, and so we see such absurd construction as a six-line high speed engine on the Heilmann locomotive, where a properly arranged three-crank engine would have been far better. Engineers well know that a single crank engine is good enough to give perfect turning in a large factory. Yet they go on making their pairs with 90° cranks. Those who have got over the 90° craze make their side-by-side compounds with cranks at 180° instead of at 0°, at which latter they could be balanced by a single weight in the fly-wheel. The simple solution of balance is the preservation of a constant C.G. for all moving masses. Given that, the balance of steam pressures may be neglected, so long as framing is equal to the stresses. Indeed, in arranging the proper mass balance, the steam balance is improved likewise, if there be any special virtue in this. But it must not be overlooked that vibration is due to mass movement, and must be dealt with on that basis.

COLONIAL CABLE COMMUNICATION AND THE PROJECTED PACIFIC CABLE.

By A CABLE EXPERT.

One of the most interesting problems of the immediate future is the commercial development of the Pacific, and the principal factor in this problem is generally considered to be the question of direct cable communication between Canada and Australia. During the last decade this important project has been exhaustively discussed. Special conferences have been held in England, Australia, and Canada at which colonial statesmen have affirmed the urgent need of such direct communication. But nothing definite has hitherto been done. At the last conference it was made evident that considerable apathy had been displayed by the Imperial Government, whose advisers evinced a tendency towards magnifying every difficulty encountered into an insurmountable barrier. On one occasion the Postmaster-General officially declared that "it would be a matter of extreme difficulty, and without precedent, for the English Government itself to become interested in such a scheme in such a way as to constitute itself a competitor with an existing commercial enterprise carried on by citizens of the British Empire." This solicitude for the interests of a joint stock company, displayed at the expense of the Canadian and Australasian colonies, has hitherto served to delay the establishment of this much-needed cable. But times have altered, and recent events have clearly demonstrated the need of this direct communication which promises a duplicate route to Australia and the far East. There has, therefore, been a marked change in the attitude of the Imperial Government since the advent of the present administration, as well as in that assumed by the Australian colonies. As for the Canadian Government, it has consistently supported the scheme from the first, and is now taking the lead in the work of practical realisation. This is mainly due to the persistent efforts of Mr. Sandford Fleming, who has made a special study of this question. India, being a partner with the existing companies, cannot reasonably be expected to favour a reform which must inevitably result in a loss to her revenue. Mr. Secretary Chamberlain is understood to fully recognise the need for an alternative all-British route to Australia, *via*, Canada. It is not now considered expedient or even just to perpetuate a monopoly prejudicial to general interests. Moreover, the existing cables are dominated by many foreign governments, and would, in time of danger, become practically useless. Points of landing might be seized, communications, official and private, would be exposed to the arbitrary censorship of hostile states, while in many cases the cables would in all probability be cut out of communication immediately and absolutely, and no source of telegraphic communication by British controlled cables would remain available, whatever might be the gravity of the crisis. In the present disturbed state of international politics the dangers of such complete isolation need no demonstration. The colonies are anxious to see this work executed without further delay. 1. Because the heavy burdens imposed on them by the policy of the existing company compel them to seek relief in an alternative route which shall relieve them from a monopoly, the risks of frequent interruption, and the serious dangers of foreign interference,

which must always exist so long as their cable communication remains at the mercy of various foreign and possibly hostile states. 2. Because the commercial community recognises that fairer tariffs and a more reliable service will result. 3. Because immediate action is imperative, there being other nations in the field preparing to lay and control this cable should the present opportunity be allowed to escape. Realising that a decisive battle for commercial supremacy is destined shortly to be fought in the Pacific Ocean, the leading Colonial statesmen are naturally desirous that their people should be fully equipped for the struggle. They see that as foreign influence increases in the Pacific, rapid independent means of inter-communication will become indispensable. The nation which lays the Pacific cable and puts the first fast line of steamships on this route may reasonably hope to obtain the controlling position in these immense regions, which are destined to enormous development. Thus, in the efforts the colonists are making to promote the immediate execution of this project, they are not only studying Colonial interests, but are also consolidating the power of the British Empire in the Mediterranean of the East.

The American Government has already expended large sums in surveying the best route for a Pacific cable. Very recently Mr. Chauncey M. Depew, speaking at a meeting of the New York Chamber of Commerce, said: "No power can estimate, and no language adequately state, the benefits of a cable. Commerce is revolutionised, communication between different parts of the earth is infinitely quickened, and intelligence is widely disseminated. People are benefited in cheaper living, better homes, higher thinking, broader education. Peace is promoted among nations. The value of the cable has been inestimable on the Atlantic side, and the same advantages will accrue to the Pacific coast of America when a cable is laid with communications to China, Japan, Hawaii, and Australia." If, as Mr. Depew anticipates, such immense benefits must accrue to the United States from the establishment of this cable, may it not be assumed that the advantages would be equally great for the British Empire and its Colonies on both sides of the Pacific? The French have actually laid what they term "the first link of the chain destined to connect Australasia with North America." They do not seem to care on what territory they land in America, and the first point at which they touch on the other side is the French settlement of New Caledonia. Mr. Audley Coote, a member of the Legislative Council of Tasmania, is acting for this group of French capitalists, who are supported, morally and financially, by their Government—anxious to extend French influence in the Pacific. It is somewhat difficult to understand by what means Mr. Coote persuaded the New South Wales and the Queensland Governments to guarantee an alien scheme destined to prejudice British interests in the Pacific. It can only be conjectured that the indifference formerly displayed by the Imperial Government compelled them to seize this opportunity of securing cable connection across the Pacific—even though offered by a foreign syndicate. However, in consequence of the protests of the other Colonial Governments, and the strong representations of the Colonial Secretary, who ultimately realised the gravity of the situation, it has now been arranged that the two Governments in question shall co-operate in the construction of an all-British route.

No discussion of this question can be attempted without referring to the existing cable company—the Eastern Extension. Whilst it is admitted that great praise is due to the promoters of this splendid enterprise, in which such signal ability—scientific, diplomatic and commercial—has been displayed, it is impossible to deny that one of the greatest stumbling blocks to the establishment of this projected cable has been the persistent hostility of the Eastern allied companies, which, in the discussion of what is really an Imperial question, would appear to have lost sight of every interest but their own. It is generally supposed that the Eastern companies were the pioneers of telegraphic communication to the East. But such is not the case. As far back as 1860, an important line of cables had been laid to India from Suez. Moreover, before the Eastern companies laid their cables, a land line system to India was already in operation, and with this company they engaged in active competition. Their strongest objection to the new enterprise is that it would result in a dead loss to them of £90,000 per annum. This objection is fully met by the projectors of the Pacific cable, who say in substance:—"Our proposal embodies a project to combine the Australasian cable system under one management, to lay a cable across the Pacific from Australia to Canada, and to provide for taking over, at valuation, whenever the company may desire, all the cables of its existing Australasian system. Whilst convinced that a change is indispensable in the public interest, we recognise that the existing company is entitled to just and reasonable consideration. If the new Pacific cable is destined to destroy its monopoly and suppress its profits, it is only right that provision should be made to guarantee the shareholders the full value of their property. With the data furnished by the company, it will be easy for an actuary to prepare an estimate of the value at any given year of its entire system of cables. That valuation once equitably established, the company would be free to accept the terms of purchase, or to continue working its cables under the altered conditions." The increase of traffic resulting from the establishment of cheap rates would probably enable the company to earn fair dividends on its capital, unless the Colonies should exercise their undoubted right to send all the Australasian traffic over what would be practically their own cable. Other Governments have adopted this policy in similar cases, and it is strictly in accordance with reason, usage and common sense. For instance, this right was exercised by the French Government in the case of the 1869 French Atlantic cable. When Baron Erlanger obtained the concession from Napoleon III., it contained a stipulation that for a certain number of years all Continental trans-Atlantic traffic, not otherwise marked by senders, should be transmitted by the above-mentioned cable. Indeed, it is understood that the British Post Office even now exercises a similar right with regard to Atlantic traffic in favour of a certain company, as the result of special stipulations existing in 1870. Should the Colonies exercise this right, their messages would be sent over the Government cable, unless otherwise marked by the senders.

The new route from England to Australia *via* Canada is about 700 miles longer than the Eastern Company's foreign route. But both the landline services aggregate about the same length. The Canadian system is, however, entirely free from foreign interference and much easier to keep in repair, because it runs along a railway instead of traversing a desert. The president of the Canadian Pacific Railway recently declared that it is possible to communicate from Vancouver to the Atlantic seaboard by one transmission, and that five million words of Pacific cable traffic could be transmitted rapidly and accurately every year *via* Canada to England at such rates as might be necessary to meet any competition likely to arise. By its various connections his company can guarantee a permanent, uninterrupted service.

With regard to the prospects of traffic, the Eastern Extension Company's own reports prove that they have paid large dividends, renewed their cables, and built up a solid reserve fund. This company has received about £800,000 in subsidies and grants. Thus these Colonial Governments have paid from the public exchequer a capital sufficient to represent the whole of the company's system which controls Australasian business. Whilst the colonies have been almost ruined by a succession of financial disasters and unparalleled depression in trade, this fortunate company has never ceased to flourish. Even at the close of the year 1893 the directors were able to boast that the sum of £633,686 had been accumulated as a reserve, after paying out of revenue the cost of new cables and cable repairs to the extent of £1,160,685. These are very large sums to be realised out of revenue, especially when they constitute an addition to the handsome dividends paid with such unfailing regularity. It would seem impossible to avoid the conclusion that the Eastern Companies have found colonial communication an extremely lucrative enterprise.

Coming to the question of the practical execution of the work, we find that at the Colonial Cable Conference held at Ottawa in July, 1894, five resolutions were passed. The fifth was as follows:—"That the Canadian Government be requested to make all necessary inquiries, and generally to take such steps as may be expedient in order to ascertain the cost of the proposed Pacific cable, and promote the establishment of the undertaking in accordance with the views expressed in the conference." The Canadian Government forthwith advertised in England, inviting cable manufacturers to tender for the laying and efficient maintenance of

a cable across the Pacific Ocean from Canada to Australia. The tenders received from four old-established, responsible firms, clearly proved:—1. That the project is perfectly practicable from every standpoint. 2. That Great Britain can indisputably obtain direct cable communication with her Australian colonies by an all British route. 3. That preliminary surveys are totally unnecessary, the contracting firms being fully prepared, with the data already available, to lay the cable and guarantee its success from a technical standpoint. 4. That the outlay of capital required is even less than the amount estimated by official experts.

The Canadian Government asked for tenders in three different forms, viz.:—Form A. The cable to be owned and controlled by Government, to be worked under Government authority, and to be kept in repair by the contractors for the first three years. Form B. The cable to be owned, maintained, and worked by a company under a fixed subsidy for a term of years. Form C. The cable to be owned, maintained, and worked by a company under a Government guarantee of traffic for a term of years. The only tenders received were according to Form A. This was probably because the Governments concerned had predetermined the maximum tariffs, in order to prevent a subsidised or traffic-guaranteed company from combining with the existing company to the public detriment. Such "pools" have been frequent between Atlantic cable companies. Under Forms B and C the maximum rates for Anglo-Australian traffic were to be 3s. per word for ordinary telegrams, 2s. for Government despatches, and 1s. 6d. for press messages, Canadian-Australian messages to be charged at proportionate rates. Tenders were asked for and obtained for eight different routes. Of these, three have a double terminus at the Australian end, one branch going to New Zealand and another to Tweedmouth, near the boundary of New South Wales and Queensland. Three go direct to Queensland and two to New Zealand only. But the route that seems to have the best chance of being adopted is No. 1. This commences at Vancouver Island, with intermediate stations at Fanning Island, Fiji and Norfolk Island. Branches extend from Norfolk Island to New Zealand and New South Wales. This is one of the longest routes, the total distance being approximately 7,145 nautical miles. The shortest of the eight routes aggregates 6,246 miles. The lowest tender for route No. 1 is :—

For a 12 word per minute cable	...	...	£1,517,000
„ 15 „ „ „ „	...	...	£1,672,000
„ 18 „ „ „ „	...	...	£1,880,000

The other tenders for a 12 word per minute cable were respectively £1,826,000, £2,170,000, £2,350,000. The lowest tenders quoted satisfy the specifications issued, and embody all the latest electrical improvements. They include the erection of suitable cable stations, duplicate sets of all proper instruments, also the use of two steamships fitted with cable tanks and all necessary repairing machinery and the cost of maintaining these ships, as well as the cables, for three years. Approved types of cable are to be used, the core of the long section is to have a copper conductor weighing 533 lbs. per knot, insulated with gutta percha weighing 365 lbs. per knot. The sheathing is to be the same as for the deep sea type of cable adopted in the newest transatlantic cable and the intermediate cables and shore ends are to be of suitable weight and character. The cable can be manufactured at the rate of 20 knots per day, and can be finished, shipped, laid and opened for traffic within two years from the date of the signing of the contract. It is interesting to note that the estimate furnished by the British Postmaster-General for the above work amounted to £2,924,000. This estimate was exclusive of maintenance for three years, as in the above tender. Nor did it include connection with Australia, which work would have necessitated another £200,000. Thus the Governments interested have a definite offer to lay and maintain for three years a cable from Vancouver to Australia and New Zealand, with a speed capacity 50 per cent. higher, and costing £1,244,000 less than the cable estimated for by the British Government experts.

The question of revenue has been carefully considered, and the following estimates—prepared by Mr. Sandford Fleming—are based on authentic information respecting the existing telegraph business, which has never ceased to increase, despite high tariffs. The deductions drawn therefrom have been submitted to men of experienced judgment and of perfectly unbiassed minds like Mr. Johnson, statistician to the Dominion Government, Mr. J. M. Courtney, the Canadian Deputy Finance Minister, and Mr. W. Hepworth Mercer, a prominent official of the Colonial Office, who has been specially charged with everything relating to Colonial cable communication. After a careful examination of the data furnished, they have fully substantiated, as far as it is possible to do so, the following estimate of probable revenue.

(To be continued.)

RECENT EXPERIMENTS WITH THE GLOBULAR DISCHARGE.

Globular lightning has long been one of the most mysterious and inexplicable of natural phenomena. Many physicists, indeed, still doubt its existence, and attribute the considerable amount of evidence as to its existence to some kind of optical delusion on the part of the observers. No reliable photographs of globular lightning, as far as we are aware, have been obtained, and in default of these the only line of investigation open appears to be to attempt the artificial production of this peculiar kind of discharge. Professor Righi, of Bologna, has been working in this direction, and has succeeded in producing a globular discharge from a powerful Leyden battery, which seems to possess a certain analogy to globular lightning.

About four years ago, Righi* obtained from a large condenser under suitable conditions, a discharge characterised by a luminosity which originated near the positive electrode, augmented in dimensions, then detached itself from the electrode and travelled, with a relative slowness, towards the cathode, which, however, it never reached. Behind this first flame others were formed, and the discharge from being simple, became compound. In his recent experiments, Righi has frequently obtained luminous masses of forms very different from the ovoid observed in the earlier experiments.

An indispensable condition for the production of globular sparks is that the circuit of discharge must have a very great resistance, which may be realised by introducing into the circuit a column of distilled water. But it is also advisable that the condenser should have a very great capacity, since the greater it is, the slower will be the movement of the luminous mass; it is necessary also that the gas in which the phenomenon is produced should be suitably rarefied, since, under these conditions, the dimensions of the flame increases, as well as the length of the path over which it travels.

The speed of the luminous masses is more or less great according to circumstances. The speed may be so great that it can only be observed by a revolving mirror. If the speed is not very great (for instance, a metre per second) and particularly if the discharge is simple, that is to say, made up of a single luminous mass, its existence and movement can be directly perceived, although the eye is not able to follow its displacement. In his present experiments, Righi has endeavoured to render the movement of the luminous mass as slow as possible, and to increase, at the same time, the duration of its visibility. He has been able in certain cases to obtain luminous masses lasting for several seconds, which moved with sufficient slowness for the eye to be able to follow the movement without difficulty; he has been able even to obtain masses which have remained stationary for a certain time, so that they could be photographed by moving the shutter by hand.

To retard the movement of the luminous masses, it is sufficient to increase the capacity of the condenser. This latter was, in his first attempts, composed of 108 large jars, which were almost always arranged to form two batteries of 54, mounted in series or in cascade. The capacity of the system was then equal to that of 27 jars; but a large Holtz machine with four plates, turned by hand, was hardly sufficient to charge it.

By putting all the jars in a single battery, the capacity was made four times greater, equal, in fact, to about 0·075 microfarad, but, in this case, the leakage was so active that the condenser charged itself very slowly, and was not able to reach the potential required for the experiment. The difficulty was got over, however, by giving

* Mem. della R. Acc di Bologna, serie V. t. I., p. 315.

a considerable angular velocity to the plates of the machine by means of a hydraulic motor. The battery could then be charged to a potential capable of giving a spark of 2 cm. in air, which was sufficient for experiments on the globular discharge.

This augmentation of the capacity is the only modification on the previous experiments which has been introduced; the discharge circuit includes a spark micrometer, a tube full of distilled water which was frequently changed, and the glass tube furnished with metallic electrodes, and containing a gas more or less rarefied for producing the globular discharge.

On account of the great influence that the dimensions of the tube have on the luminous phenomena which are produced in it, and also to avoid possible complications in the majority of these experiments, tubes of the same size have been used, *i.e.*, 38 cm. long and 4 cm. in diameter. They were furnished with electrodes of platinum or aluminium wire.

When the potential of the battery reaches a certain value a spark strikes through the air between the balls of the exciter, and at the same time the phenomena, being investigated, are produced in the tube. By using great resistances and a large battery, the duration of this phenomenon and of the spark may be made to exceed a second in length. Of course, according as the resistance is augmented or diminished by means of the column of liquid, the spark in the air is of the second, third, or fourth type,* and produces in the two last cases a sharp and prolonged hissing.

Although he has obtained, in this way, globular discharges of relatively slow movement and long duration, he has frequently employed another method which enables discharges of a still greater length to be obtained.

It is known that the spark of the first type, *i.e.*, the ordinary spark, has so short a duration that any movement of the electrodes during the discharge has no sensible influence on its duration. But it is no longer the same if a high resistance is introduced in the circuit; it is possible, in this case, to vary the length of the spark gap while the spark lasts, for instance, to bring the balls to contact when the discharge has scarcely commenced.

In this way the discharge commences when the balls are apart, and continues in a circuit which may contain no other spark gap. A great duration is thus obtained, which increases with the potential, the capacity of the condenser, and the resistance of the circuit. The discharge thus produced has been called by Righi the retarded or prolonged discharge.† It is easy to estimate the duration of the discharge by means of a small spark gap in the circuit, other than that which is suppressed at the moment the discharge commences. The duration of the discharge increases as the length of this little gap is reduced.

In the actual experiment, the tube in which the globular discharge is produced indicates the duration of the phenomenon, which may be for several seconds.

Practically, the time for closing the spark gap is indicated by a pendulum electrometer. The exciter was sometimes suppressed by putting its two electrodes in contact, and the circuit of discharge was kept open by means of an inverter, the movable arms of which were carried to their place only at the moment when it was desired to provoke the discharge.

The prolonged discharge appears to behave like an electric current, the intensity of which increases rapidly at first, then more slowly to a maximum, then diminishes to zero.

(*To be continued.*)

ON SECONDARY BATTERIES FOR ELECTRICAL LOCOMOTION.

By DESMOND G. FITZ-GERALD.

(*Continued from page* 367.)

In addressing the following communication to a friend who was taking an active interest in electrically-propelled automotric (in contradistinction to automobile) vehicles, I assumed as obvious, 1st, that before we undertake any work we should consider whether we can do it as well as, if not better than, some others; and, secondly, that to arrive at a correct conclusion in the above case, we require to have definite notions as to what has already been and what is actually being done in regard to that work. My friend, however, did not, apparently, agree with me, as he returned my communication as "not being of any use," and has not acted in accordance with its recommendations.

"Dear Sir,—The following technical advice and suggestions are limited to automotric tram cars, but of course have a certain bearing upon other automotric vehicles. In offering them, I assume it to be necessary that you should be in a position to demonstrate the following propositions by means of verified facts and figures, supplemented by continuous experiment on a small but sufficient scale:—

"1. That automotric electrical tram traction, although hitherto a failure, financially, in this country, has been proved abroad, and notably by the Société des Tramways de Paris et du Département de la Seine, to be commercially practicable and advantageous, even under conditions which admit of very considerable improvement.

"2. That you and your friends are prepared to demonstrate, experimentally, not only that they have at their command means and appliances which enable them to obtain results equal to those which have proved successful; but that they are able to realise these results under conditions which constitute a considerable practical improvement.

"The most important of the recent sources of information relating to automotric (and automobile) vehicles are:

"(*a*) The papers and tables relative to 'The Working Expenses of Electric and Cable Railways,' published in the *Railway World* September and October, 1894, and September, 1895.

"(*b*) The communication to the Société Internationale des Electriciens, from M. Jules Sarcia (of the Société anonyme pour le Travail Electrique des Métaux), relating to a total of nearly 2,000,000 car kilometres (1,242,000 car miles), from January 1st, 1892, to December 31st, 1894. (See Electrical Review, August 2nd, 1895.)

"(*c*) The report of the Commission appointed (Paris, June, 1895) to investigate the various systems of traction by electricity.

"In considering these documents, I have accepted as evidence only such statements and figures as could, at least, approximately, be verified by comparison with other data, or by calculation and inquiry.

"In regard to the first matter for demonstration. From (*a*) it appears to be beyond doubt that the position of automotric electrical tramcar traction in this country is (at least, up to a recent date) fairly represented by the following figures, applicable to the Birmingham (accumulator) tramline:—

Cost of working per car mile	...	...	20½d.
Receipts per car mile	...	...	15·7d.

"Thus the line is, or has been up to a recent period, worked at a considerable loss.

"On the other hand, it appears from (*b*) and (*c*) that, although the cost of maintenance and attendance in respect to the accumulators used is unduly high, the cost of working the automotric system in Paris is, per car mile, only 7½d."

(Details in relation to the accumulators, which have already appeared in these columns, were here given.)

"In regard to the second matter for demonstration, there is no necessity to experiment, in the first instance, with an accumulator weighing 3 tonnes, such as was used in Paris for the propulsion of a car weighing, with passengers, about 20½ tonnes. Nor is it even necessary to use a battery of which the weight is an aliquot part of the above. But, whatever cell be selected with a view to obtain *primâ facie* comparative results, must be so constructed as to suggest that it is well adapted to withstand the shocks and vibration incidental to the traffic for which it is intended; and such cell must be rejected unless the experimental trial, extending over (say) one month, should prove, so far, that it complies with following conditions:—

"1. The mean ratio of power to gross weight throughout the discharge must attain, and should exceed the following value:—

$$\frac{\text{watts}}{\text{lb.}} = \frac{385}{321} = 1{\cdot}20.$$

"(The weight of accumulator per ton of traction weight should not exceed 321 lbs., and this should be able to

* Mem. della R. Acc dei Lincei, 3 serie t. I.
† Mem. della R. Acc. di Bologna, 3 serie t. VII., p. 193.

supply 385 watts on the average during the whole period of the run.)

"I should prefer to take 1·35 as a minimum value.

"For short periods of time, the accumulator should be able to maintain a power of about 4 watts per lb. On the other hand, in descending a gradient, 'power absorbed' may have a negative value, energy being recuperated in the accumulator.

"2. The mean rate of discharge for the whole period of the discharge should attain the following value:—

$$\frac{\text{amperes}}{\text{lb.}} = \frac{35}{60} = \cdot 58.$$

"That is to say, a battery weighing 60 lbs. should be able to supply a mean current of 35 amperes during the whole period of discharge.

"Moreover, the accumulator must be able to withstand for short periods (the *coups de fouet*) a maximum rate of discharge expressed by

$$\frac{\text{amperes}}{\text{lb.}} = \frac{120}{60} = 2.$$

"The apparent specific (quantity) capacity of an accumulator varies according to the rate of discharge. Taking the above minimum of ·58 ampere per lb. gross weight of accumulator, this value for certain cells used in Paris is:—

$$\frac{\text{ampere hours}}{\text{lb. of accumulator}} = \frac{230}{60} = 3{\cdot}83.$$

"The period of discharge would thus be:—

$$\frac{\text{capacity}}{\text{mean rate of discharge}} = \frac{3{\cdot}83}{\cdot 58} = 6{\cdot}6 \text{ hours.}$$

"One charge of the accumulators in question would thus last during three double journeys from St. Denis to the Madeleine and back; the time occupied in the double journey being registered as 56 + 55 minutes = 1 hour 51 minutes.

"(Note.—Since the distance traversed in the double journey is a little over 19 kilometres, or 11·8 miles, the average speed would be about 6·4 miles an hour.)

"Thus, during the first single journey, the car is carrying the energy—or, rather, the material for supplying the energy—required for the five subsequent journeys. In other words, it is hauling 3 tons, instead of half a ton, of storage battery. Unless we suppose manutention to be very laborious and costly, this condition is obviously defective from the point of view of economy. It appears to have been imposed by the circumstance that no battery was available, or known to be available, that would meet the required rate of discharge with less weight and less capacity.

"What is required, and what certainly is attainable, is a storage battery satisfying the above-mentioned condition as to withstanding shock and vibration and susceptible of being discharged, without excessive fall of potential, within a period of (say) not more than 2 hours. The rate of discharge, expressed by the ratio $\frac{\text{amperes.}}{\text{lb.}}$ must be augmented proportionately to the diminution of weight effected by reducing the capacity of the accumulator from 3·83 to 2 ampere-hours. Thus, the weight of each cell of the accumulator required to supply a mean current of 35 amperes being reduced from 60 lb. to $60 \times \frac{2}{3{\cdot}83} = 31{\cdot}3$ lb., whilst the current remains constant, the rate of discharge, or the current per lb. in each cell, would be increased from ·58 to $\cdot 58 \times \frac{3{\cdot}83}{2} = 1{\cdot}11$. The maximum rate of discharge for short periods of time would then require to be 3·5 amperes per lb. gross weight of battery. Such an augmentation of the rate of discharge, with the corresponding reduction of the period of discharge, and of the weight of the accumulator is, no doubt, as I have said, within the limits of practicability, and if so, is very desirable, though not essential at the present moment.

"In regard to the other datum values above given, it would, I think, be futile to enter into the competition which has been initiated in relation to electro-automotric tram carriages unless they can be realised by yourself and your friends under the conditions of practice.

"I am, &c.,

"Desmond G. FitzGerald."

A period, let us hope, is approaching when practically accurate data, such as the above, will have to be taken into consideration and acted upon by those who come before the public with electro-automotric systems. With accumulators intended for other applications, commercial success may sometimes be achieved by bold assertion and an extensive system of advertising. But, in electric traction, short shrift will be given to secondary batteries and systems that are found to be deficient as compared with others that may be available.

An interesting question now to be considered is: What weight of useless electrolyte, if any, has it been customary to carry on board tramcars driven by accumulators under the "rule of thumb" system of constructing the latter, which has generally prevailed?

(*To be continued.*)

THE RÖNTGEN X RAYS.

Tesla continues his experiments in the production of X rays by his high frequency currents, and has communicated in a letter to the *Electrical Review*, N.Y., some more very marvellous results. Using his unipolar lamp and his high frequency apparatus, he has obtained strong Röntgen photographs at a distance of 40 feet, and he sees before him the possibility of producing the same effects at ten times that distance. He has also succeeded in reflecting the X rays by a sheet of glass. Only about 2 per cent. of the radiation is reflected by glass. With denser substances, no doubt, a much larger proportion would be reflected, as we already know to be the case in the focus tube.

Tesla's further experiments appear to him to confirm his view that the X radiation consists of material streams, and certainly some of his results are difficult to explain on any other hypothesis. He says:

An experiment which is illustrative in this respect, and which I intended to mention, is the following: If we attach a fairly exhausted bulb containing an electrode to the terminal of a disruptive coil, we observe small streamers breaking through the sides of the glass. Usually such a streamer will break through the seal and crack the bulb, whereupon the vacuum is impaired; but if the seal is placed above the terminal, or if some other provision is made to prevent the streamer from passing through the glass at that point, it often occurs that the stream breaks out through the side of the bulb, producing a fine hole. Now, the extraordinary thing is that, in spite of the connection to the outer atmosphere, the air cannot rush into the bulb as long as the hole is very small. The glass at the place where the rupture has occurred may grow very hot—to such a degree as to soften; but it will not collapse, but rather bulge out, showing that a pressure from the inside greater than that of the atmosphere exists. On frequent occasions I have observed that the glass bulges out, and the hole, through which the streamer rushes out, becomes so large as to be perfectly discernible to the eye. As the matter is expelled from the bulb the rarefaction increases, and the streamer becomes less and less intense, whereupon the glass closes again, hermetically sealing the opening. The process of rarefaction, nevertheless, continues, streamers being still visible on the heated place until the highest degree of exhaustion is reached, whereupon they may disappear. Here, then, we have a positive evidence that matter is being expelled through the walls of the glass.

Lord Rayleigh, on the other hand, appears to think that there is no actual passage of radiant matter through the sides of the tube, but that another stream of radiant particles is started outside the tube owing to the impact of the cathode stream on the inside. This decidedly appears the more reasonable explanation, but the want of agreement on the nature of the X radiation only shows how little as yet we know about it.

Edison communicates to the *Electrical Engineer*, N.Y., the results of his researches, which relate principally to improved forms of tubes and other matters of detail. He finds the medium rapid photographic plates are superior to the very rapid or the slow plates. He also finds the rapidity of a given Crookes tube is, roughly, proportional to the square of the fluorescent candle-power of the total visible fluorescent light given out by the tube. The power of a tube having a given degree of exhaustion and disposition of electrodes, was found to increase with the surface area of its fluorescent walls. He found that caps of tinfoil pasted outside the tube round the electrodes protected the tubes from rupture, and increased their efficiency. His Ruhmkorff coil was used with a Siemens commutator interrupter, giving 400 interruptions

per second, and the condenser was replaced with advantage by an air blast playing upon the interrupter. The air blast tended to produce a sudden breaking of the circuit, and thus rendered the condenser unnecessary.

Elihu Thomson has come to the conclusion that the anode is the source of the X rays; but as he used the outside circuit of two Leyden jars, in which the current is notoriously oscillatory, the validity of his results is doubtful. He also found, what many other experimenters have discovered, that the vacuum of his tube increased with use, and he ascribes this to the absorption of gas by particles of metallic platinum detached from a platinum plate which happened to be fixed in the centre of his tube. But Tesla and others have found the same effect in tubes containing no platinum, so that this hypothesis appears also questionable.

M. Armagnat publishes in *L'Industrie Electrique* some experiments on this curious phenomenon of the variation in the vacuum of the tube due to the discharge. He found that when a small current, say, of 0·07 milliampere was passed through the tube, that the vacuum increased. When, on the other hand, by using a more powerful coil a current of 0·7 milliampere was sent through the tube, its resistance gradually decreased, and at the end of two minutes the current had risen to 1·3 milliampere, and the greenish fluorescence was replaced by the blue light. On reducing the rapidity of the interrupter, the current again decreased to 0·35 milliampere, and after some time it fell to its original value of 0·07 milliampere, when the green fluorescence returned. Whatever may be the cause of these curious phenomena, they will at least be important in the practical working of X ray vacuum tubes. M. Armagnat points out that analogous phenomena have been observed with electrolytes, and that the reduction of resistance with large currents may partly be due to the heating of the cathode.

Prof. Righi, in a note presented to the Academie des Sciences, describes some further experiments he has made on the discharge of electrified bodies by X rays. He found in his experiments that the electrified bodies were always left slightly positive. He ascertained that the dispersion was proportional to $\frac{v_0 - v_1}{v_1}$, where v_0 is the potential of the body before it is exposed to the X radiation, and v_1 its potential after exposure. As is well known, other experimenters have found that a negative charge is left after exposure to the X rays, but this apparent discrepancy appears to be explained by some interesting experiments communicated to a contemporary by Professor Minchin. Professor Minchin finds that the sign of the residual discharge depends on the nature of the charged body on which the X rays impinge. He gives a series of substances arranged according to the intensity and sign of their residual discharges, but this series does not appear to correspond very well with any known series arranged according to other electrical or chemical properties.

Righi describes, in *L'Electricien*, an apparatus by which he obtains the Röntgen pictures without the use of the photographic plate, by a method similar to that employed by Lichtenberg and Kundt. Under the Crookes tube is fixed a sheet of black cardboard, backed by a sheet of aluminium, which is connected to earth. Below this is fixed a sheet of ebonite, backed with tinfoil, which latter is connected through an air condenser to the cathode of the tube. The anode of the tube is also put to earth. If a hand is now laid on the cardboard, and subjected for a sufficient time to the action of the tube, it will be found that an electrical picture of the hand *a la* Röntgen has been imprinted on the sheet of ebonite. This can be made visible by the well known mixture of sulphur and red lead, or by another mixture of talc and dioxide of magnesium, which gives an effect more closely resembling a photograph. The bones, &c., are shown in these electrographs just the same as in the Röntgen photographs.

THE INSTITUTION AND ITS BALANCE-SHEET.

The members of the Institution of Electrical Engineers have again suffered the inconvenience of being called together to listen to a paper of scientific interest, and instead have had to listen to some observations on the affairs of the Institution, and once more Mr. Raworth was the culprit. But so far as responsibility for interrupting the business of the meeting is concerned, Mr. Raworth must be absolved. He suggested that the consideration of the balance-sheet should be adjourned, and when that was refused he proceeded with his self-imposed task with the evident intention of going through with it. To the remarks made at the Institution he adds others in a letter which appears in our "Correspondence" columns. He complains that he was prevented by the President from going into the question of the application of the funds of the Institution, a ruling which he considers raises important questions.

Leaving these questions for the moment, we doubt if Dr. Hopkinson's ruling would not meet with general approval, nor did it call for the interposition of the honorary solicitor. Mr. Raworth's resolution related not to the method of expenditure, but to the method of placing the accounts before the members. Mr. Raworth must be content with one step at a time. He succeeded in showing a majority of the voters that there were some features in the presentation of the accounts which might with advantage be inquired into, and he was helped in this by the fact that the accountant did not reply to the points raised. This was, we believe, partly due to the use of the words "balance-sheet" instead of the more comprehensive "accounts." Some information which Mr. Raworth wanted might appropriately appear in the revenue account instead of the balance-sheet. In the end the balance-sheet was "referred back to the Council for amendment." When it appears in an amended form before the members we hope that a special evening will be set aside for its consideration. The interruption of papers or discussions has gone far enough. A special evening would be not merely the most appropriate, but would have the advantage of demonstrating how many members take an interest in the affairs of the Institution. We presume that on another motion Mr. Raworth would have no difficulty in raising the wider questions referred to in his letter. A little healthy discussion would do a great deal to clear the atmosphere and reconcile the ardent spirits who sigh for new worlds to conquer, and are anxious to spend all they have; with the more staid and conservative council, who remember something of fighting in their day, and whose aim it is to place the Institution in a position of independence, and free from anxiety as to its permanence as an Institution. There is, of course, a mean between these two extremes, and there is nothing like healthy discussion to arrive at it. An interest in the affairs of the Institution is exemplified in calling attention to improvements which might be made in the presentation of its accounts. A similar interest is shown in suggesting modifications in its expenditure and methods. Electricity is a progressive science, and needs a progressive Society. Some members seem to be of the opinion that the Institution is not progressive enough, and these are sufficiently numerous to ensure that their opinions shall be heard. There is nothing like facing such situations as these at once, and giving the malcontents an opportunity of being fairly heard and fairly met. An opposition to the methods of the Council may be for the benefit of the Society, and Mr. Raworth is entitled to the credit which always attaches to the man who makes himself unpleasant for the general good.

His further propositions being submitted to a general meeting called for the express purpose of discussing them, and nothing else, would have their good points selected, their crudities eliminated, and probably in the end "something might be done." The result might be an infusion of progressive science with the retention of conservative business methods.

Wiring Rules.—A contemporary, in its issue of March 20th, published the new wiring rules just issued by the St. Pancras Vestry, and remarked that "these are interesting as being the first of the kind drawn up since the 220-volt lamp came down from the high regions of pioneering experiment to the commercial level." We would like to draw attention to the 25th edition of the Phœnix Fire Office rules, printed in January of this year, wherein it will be seen that Mr. Musgrave Heaphy has dealt with current supplied at 220 volts, thus forestalling Mr. Baynes.

CORRESPONDENCE.

What is an Electro-Magnet?

A paragraph headed "City and Guilds Institute," on page 421 of your last issue, raises the above question. A magnet, I take it, is anything possessing or giving rise to magnetic lines of force; therefore, an electro-magnet is one whose magnetism is dependent upon a current of electricity. Consequently a straight conductor carrying a current is practically the simplest form of electro-magnet, for it will deflect a magnetic needle, and if the current is great enough will pick up iron filings, &c. If the conductor is coiled up into a solenoid we get much greater magnetic effects, which are enormously enhanced by putting in an iron core. The above definition may seem too wide, but to argue that an electro-magnet must necessarily have an iron core or part seems wrong, and is not borne out by the wording of the exam. question quoted.

W. Perren Maycock.

How to Become an A.M.I.E.E.

Could you oblige by telling me how to become an electrical engineer, A.M.I.E.E., the list of subjects I should take up, and examinations, and oblige

G. Harrison.

March 27th, 1896.

[Our correspondent should write to Mr. F. H. Webb, the Secretary of the Institution of Electrical Engineers, 28, Victoria Street, S.W., for particulars of qualifications of membership. There is no A.M.I.E.E.—EDS. ELEC. REV.]

High Voltage Lamps.

Anent the comments of "G. T.," in your issue of 27th ult., on my paper on "High Voltage Lamps and their Influence in Central Station Practice," I think a reference to my paper and to the article I wrote in your paper about 15 months since, will make it clear that in stating that the advantages of high voltage progressed, for the voltages in question, somewhere about as the cube of the voltage. I was making a general statement and looking to the subject as a whole, and not merely at the actual cost of feeders per yard run as your correspondent assumes, which forms only one element in the calculation.

Your correspondent accepts the fact that within the same area as that at present covered, the cost of copper is cut down to one-fourth by doubling the voltage, so that the gain is about as the square of the voltage. He also acknowledges that the same quantity of copper in a feeder which now carries the current $\frac{3}{4}$ mile will, at 220 volts, carry it $1\frac{1}{2}$ miles, by which the area to be served is increased four times, the gain in the distributing mains being 75 per cent. as in the smaller area. Thus the immense advantage of being able to concentrate four times the amount of plant in one station, which is feasible at present, is secured without a larger actual expenditure on the long feeders than is required at present, in addition to the benefit mentioned above. Further, by using rather more copper than is the present practice or running at a slightly less current density, the feeders, or, by allowing a rather larger drop, can be carried easily and conveniently to cover 16 times the present economic area, thus making it practicable to concentrate in one central station 16 times the power it can at present contain, while the station could usually be moved half-a-mile from the centre to a less expensive and more convenient site at inappreciably greater cost for distribution, the cost per unit for central station plant being thus reduced, labour and administration being smaller, and the expenditure in the distributing system being the same as above.

Consequently, when all these advantages are added, I think it is clear that, taken as a whole, the advantages of using 220 volt lamps are for central stations at least as the cube of the voltage from 110 to 220 volts, and that if the facility of putting accumulators at the end of the long feeders and thus cutting down their section were taken into account in my comparison, which they were not, looking at the subject as a whole, the whole of the advantages of higher voltage are, speaking roughly and generally, represented by almost the fourth power instead of third, which your correspondent calls in question.

G. L. Addenbrooke.

Some Recent Dynamos.

With reference to your article on "Some Recent Dynamos," I should like to mention that Fig. 1, page 336, has been designed and manufactured for many years by Messrs. Schuckert & Co., Limited, Nuremberg, and is one of the best dynamos in the market.

Leon H. Cline.

March 25th, 1896.

Cost of Private Installations.

As no one seems to come forward to assist Mr. James T. Calvert in his letter, as regards the cost of, and the running of, private installations, in your issue of March 20th, I shall, at any time he may be in town, have much pleasure in showing him over a private plant, &c., somewhere about the size he would require. Also in giving him a little information as regards the economical running of the same, as (I believe) you know our installation here stands well to the front in its complete equipment, and of the fact that we are well satisfied with it from a purely commercial standpoint, perhaps he might, if possible, avail himself of the opportunity.

I also think that it would be very interesting to all concerned, if the cost per unit generated were given in your well-known columns (if possible) once a year, of some of the large private installations now running. I know of several that (I am informed) enjoy a most successful competition against supply companies, and I certainly see no reason why private plants of, say, 50 H.P. upwards, under competent engineers, cannot be made to generate current almost as economically as some of the supply companies plants.

William Durtnall,
Chief Engineer, Electric Light Department,
Cannon Street Hotel, E.C.

Differential and Integral Calculus.

Can anyone recommend a really elementary work on the above, such as would enable one with no knowledge of the subject to obtain a practical idea of its drift and application. I am sure that such information would be of value to many others besides myself.

D. T.

Secondary Battery Plates.

I venture to send you a little experience in case it might possibly be of any interest. Last year when a set of storage cells was being made, the pasted plates, after being dried, were, by mistake, immersed for several hours to harden in a weak solution of sulphuric acid, in which a small quantity of *red chromic acid powder* had been dissolved. I supposed the plates would be ruined, but to my surprise they set harder and more quickly than if they had been immersed in ordinary dilute sulphuric acid, and the plates apparently became deeply peroxidised and assumed a dark brown colour. I have since been told that this result would undoubtedly take place. The plates thus treated were then set up in the usual way in the ordinary dilute sulphuric acid battery solution, and are in every way most satisfactory after having been in regular use for some time; you will know whether it is a fact that the red lead in a lead grid turns into peroxide if immersed in a solution of chromic acid.

W. J. S. Barber Starkey.

March 28th, 1896.

The Institution of Electrical Engineers.

Last Thursday, March 26th, 1896, the Council of the Institution of Electrical Engineers, in contravention of Article 59 of the Articles of Association, brought forward a motion, which was proposed by the President, and seconded by Major-General Webber, relative to the direction and management of the concerns of the Institution, viz., that the balance-sheet be adopted.

I thereupon moved that the balance-sheet be referred back

to the Council for amendment, and although I was prevented by frequent interruptions from the Chair, and by feelings of consideration for my friend, Mr. Dane Sinclair, and for the large audience which had come together to hear his paper, from stating even the moiety of my case, the meeting, after hearing an irrelevant statement from the accountant, passed the amendment by a majority of nearly 2 to 1.

Having stated this much merely as preamble, for I do not desire to dwell further upon it, I wish now to direct the attention of members of the Institution to the attitude of the President, who was presumably representing the Council, to one subject which I essayed to submit to the consideration of the meeting. That subject was the application of the funds of the Institution. I pointed out that whereas we had a cash surplus of £1,173, the Council had only expended £23 3s. in premiums on papers, whilst the Civil Engineers had awarded £412 9s. 6d.

At this point the President interposed, and ruled me out of order, to which ruling I strongly demurred; but as the honorary solicitor did not come to my assistance, I had, of course, to submit.

Now, Sir, this ruling raises two important questions, which the President, and I presume the Council also, have entirely overlooked.

The first is that we are a limited company, constituted under the Companies Acts, 1862 to 1880 (see Articles of Association), and therefore the meeting at which the balance-sheet is presented is the annual meeting, or an adjournment thereof, quite irrespective of the designation the Council may choose to apply to it.

At such a meeting, it is competent for any shareholder (*i.e.*, member) to raise any question bearing on the management of the company or the administration of its funds.

The second is, that the objects of the Institution, as described in the Memorandum of Association, are principally as described in clause 3 B and section B 5.

3 B. "To promote the general advancement of electrical and telegraphic science and its application."

B (5) "To make grants of money, books, apparatus, or otherwise, for the purpose of promoting invention and research in electrical or telegraphic science."

Clause 4 states that "the income and property of the Institution, from whatever source derived, shall be applied solely towards the promotion of the objects of the Institution, as set forth in the Memorandum of Association."

Up to the present time the funds of the Institution have not been applied as directed above, except to a very limited extent not exceeding £25 a year.

The publication of the *Journal* may, perhaps, be considered *accessory* to those objects, but it is accessory *after* the fact, and not before it.

If, however, we have not done those things for which the Institution was founded, and for which subscriptions have been paid, we have been both active and successful in doing certain other things not provided for in the memorandum, namely, in establishing a most flourishing savings bank and building society—both excellent things in their way, but quite irrelevant to the promotion of the advancement of electrical science.

It was pointed out by a member of Council at the annual meeting, years ago, that we could only exist so long as we were solvent, but insolvency is not the disease we are suffering from, so we need not worry about it. The canker which is paralysing the Institution is AVARICE. We have committed to the Council, as a sort of ward in Chancery, a youthful and charming maiden, the pole star of our existence and the embodiment of our hopes, we have provided funds for her maintenance and education, and have handed over a memorandum setting forth the manner in which we wish those funds *to be spent*, but the appointed guardian has consigned his fair ward to the coal cellar, there to languish unfed and uneducated, while he counts up continually his ever-increasing pile of gilt-edged securities.

The Society for the Propagation of the Gospel will soon hold its annual meeting in Exeter Hall, and to its thousands of enthusiastic subscribers will give an account of its stewardship. If its assets are found to consist of a record on new fields opened, new converts made, and the gospel everywhere advancing, there will be great rejoicing, and the verdict will be: "Well done, thou good and faithful servant;" but if, on the contrary, the assets are found to consist of consols, Cape bonds, 3½ per cent. preference shares, and a few volumes of musty records, the indignant subscribers will not only express their anger in forcible language, but will divert their gifts into other and more profitable channels.

A man's life consisteth not in the abundance of the things which he possesseth. It is better to *live* on the verge of insolvency than to *die* worth a million.

The Northern Society of Electrical Engineers, which exists on next to nothing a year, and meets in a small upper room for which it pays rent, has already, in the short period of its life, done more to further the objects of its constitution than its more luxurious parent, with all its wealth of gold and titles, and its palatial but elemosynary environment of marble magnificence.

John S. Raworth.

P.S.—The above letter must be read as a statement of principle, absolutely free from any personal feeling. I do not wish to suggest that I, or anyone, unaided by an intelligent interest on the part of the members generally, would, or could, have guided the Institution more successfully than the Council has done.

The Institution Accounts.

As I have not had any reason to look for dividends from the Institution, I fear I have been somewhat remiss in my perusal of the annual statements of accounts. Since, however, Mr. Raworth has called our attention to the subject, I have, as a matter of interest, looked over the statements of accounts for 1893, 1894, and 1895.

If there is any object in issuing these accounts, I certainly think they should be submitted in a satisfactory form, although, for my own part, I am quite satisfied that the Council should keep the accounts in whatever way they think fit.

I do not consider that the form of accounts as now presented can be regarded as satisfactory.

To take one item—that of "Life Compositions." The Articles of Association provide that "all such compositions shall be invested, and the interest alone shall be appropriated to the current expenditure." In 1893 the amount received under this head was £206, the amount invested during the year was £204 10s., and the total investment on this account was £2,497. In 1894 the amount received was £362 10s., and the amount invested during the year only £204 16s. 6d., and the total amount invested £2,701 16s. 6d., leaving a balance on the two years to be invested of £159 3s. 6d. Now, in 1895, the amount received was £277 10s., but as much as £552 5s. 4d. was invested, bringing up the total amount invested to £3,254 1s. 10d. According to this, it would appear that the sum of over £100 must have been in suspense from some period prior to 1893. I have no wish whatever to complain of this, if the Council think fit to deal with the fund in this way, but it is not a satisfactory way of making up accounts that the balance of the life compositions not invested was not shown. The total amount of the life compositions is this year shown for the first time since 1893 at £3,272, of which only £3,254 1s. 10d. is shown to be invested. Is the balance in the general fund? Would it not be more correct to show a separate account of the life compositions?

The same kind of thing appears in connection with the Salomons Scholarship fund. The amount received for interest in 1893 was £51 1s. 8d., and the amount spent in awards was £70; but nothing is said of any balance on either side. In 1894, the amount received was £50 17s. 3d., and the amount expended was £50, and the statement shows a balance of £32 5s. 2d. How this balance is made up does not appear.

There are other items I might refer to, but I do not wish to take up too much of your space. I would like, however, to point out the extraordinary discrepancy between the statements in the annual report presented on December 12th, and the statements of accounts. In the report it is stated:—"The following investments have been made during the year, viz., £554 17s. 8d. on account of life compositions, and £1,099 19s. 6d. on account of general investment fund." No such figures can be traced in the accounts, which show only £552 5s. 4d. invested during the year on account of

life compositions, but as much as £1,300 12s. 8d. on account of general investment.

The report also says :—"The annual accounts, when made up to the end of the year, will, in all probability, show a surplus equal to that of last year." Now, the surplus at the end of 1894 was £10,712 8s. 1d. At the end of 1895, however, no surplus whatever is shown, and in place of it there is a general fund balance of £3,279 18s. 9d., whatever that may be. The disparity between these figures arises out of the premium fund, the life compositions fund, the telegraphic jubilee fund, the Salomons Scholarship fund, and the building fund, being this year regarded as liabilities, while in previous years the Council, according to the accounts, regarded these items as assets.

Now that the Council have by these accounts raised a doubt in my mind, I should certainly be very much interested to learn from some one able to enlighten us, what these items really are.

I have no doubt, as the Council say, that the surplus this year is equal to that of last year, but it certainly is not correct to say that the accounts show it.

E. Garcke.

March 31st, 1896.

Electric Elevators.

On reading the letter of Messrs. Waygood & Co., in your issue of the 27th ult., I have pleasure in making, as promptly as possible, the *amende honourable* suggested by them. I regret that, through insufficient information, I was led to entertain a wrong impression. One of my directors was in Cape Town, as stated in a previous letter, stopping at the Grand Hotel, in which hotel one of Messrs. Waygood & Co.'s electric lifts was being fixed, and it was this one to which reference was particularly made. It seems curious that our director was given no intimation of other lifts in Cape Town, and, in the absence of such information, his conclusion was perhaps not an unnatural one. In any case, I am glad, for the sake of Messrs. Waygood & Co., to have elicited the explicit information contained in their last letter.

I do not know the precise force of the expression of their closing paragraph "as an English firm," in view of the fact that this also is an English company.

Wm. Augs. Gibson,
Managing Director, Otis Elevator Company, Limited.

March 30th, 1896.

A TRADE MARK CASE IN THE HOUSE OF LORDS.

Messrs. Reddaway, the makers of camel hair belting obtained an injunction from Judge Collins, at the Manchester Assizes, restraining Messrs. Banham and Company from infringing their trade mark by using the description "Camel Hair Belting" stamped on their products without also stamping their own name, the jury taking the view that the intention was to simulate Messrs. Reddaway's long-advertised material. The Court of Appeal reversed the decision, on the grounds that Messrs. Banham simply stamped the material with a name which explained the material of which it was made, much the same as though if it had been of linen, it might have been stamped linen with perfect propriety. To us there seems very good grounds for thinking that there is no harm done in stamping a material with a correct description, and the first Court evidently considered that had the name of Messrs. Banham also been put on their own material there would have been no ground for complaint. It certainly seems hard that a natural product should not be perfectly free to be used by anyone, and it scarcely seems fair that the use of the name of a natural product should be monopolised for ever by the firm who first used it. Were such the case, the language would be too meagre to get about the description of articles of every-day use. We should be precluded from speaking of a "linen" thread or a "steel" boiler. The House of Lords now reverses the appeal, and gives Messrs. Reddaway, we suppose, the right to the words camel-hair belting except—and on this point, to the lay mind, the Lord Chancellor's judgment appears uncertain in the report before us—where another maker uses them in conjunction with his own name. The moral of the whole is that, in the first place, a manufacturing firm would do well to use some meaningless term as a trade mark to the avoidance of the use of absolutely descriptive words to which the whole world has an equal *primâ facie* right; and, in the second place, those who think they have a right to the use of truthfully descriptive words, should use them with their own names. A manufacturer ought not to be ashamed to stamp his own name on his own goods. Our friends, the Germans, do us the kindness of stamping "Sheffield" on the cast-iron cutlery made in Germany. But where a manufacturer clearly and unmistakably stamps his name in sufficient proximity to a descriptive term like "camel hair," where the description really describes his goods, we cannot see that prior users have ground for complaint. Now, Messrs. Banham did not so stamp their name, but used the descriptive term apparently to pass the stuff as though made by Reddaway. This was the Lord Chancellor's opinion of their motive, and Messrs. Reddaway have thus won the day, not so much because they had a right to the term they claimed, as because their competitors were not sufficiently proud of their own name to mark it on their own goods.

LEGAL.

Lazare, Weiller & Co. *v.* Bolton & Sons.

In the Court of Appeal last week, before the Master of the Rolls, Lord Justice Lopes, and Lord Justice Rigby, the plaintiffs appealed from a judgment of Mr. Justice Mathew, which is recorded in the Electrical Review for February 28th, 1896. At the trial Mr. Justice Mathew held that there had been a breach of contract on the part of the defendants, and, further, that there had been a breach by the plaintiffs of the collateral agreement. The plaintiffs appealed, and contended that there had only been one contract, and that the alleged collateral agreement was not a contract at all. The defendants relied on the collateral agreement as going to the root of the whole matter, and further contended, by way of cross appeal, that they had been induced to enter into the original contract by misrepresentation.

Mr. Bigham, Q.C., Mr. Joseph Walton, Q.C., and Mr. Rufus Isaacs appeared for the plaintiffs; Sir Edward Clarke, Q.C., Mr. Lawson Walton, Q.C., and Mr. Wills for the defendants.

The Master of the Rolls said that the action was brought by the plaintiffs for breach of contract on the part of the defendants in not accepting certain copper wire. The defence was that the defendants had been induced to enter into the contract by misrepresentation on the part of the plaintiffs. It was not alleged that there had been any fraudulent misrepresentation, but that a misrepresentation had been made with regard to the extent of the plaintiffs' trade, and that the defendants had relied on the representation so made. The defendants therefore claimed that they were entitled to have the contract set aside. The learned Judge at the trial came to the conclusion that no misrepresentation had been made by the plaintiffs, and, further, that, if any misrepresentation had been made, the defendants had not relied on it. In his opinion the learned Judge had been quite justified in so finding. Therefore, if the contract stood by itself, there was no defence to the action. But the defendants said that there was a collateral contract in addition to the original contract, in the shape of a letter which was written on the same day. The learned Judge had held that this letter was a contract. But, in his opinion, when the terms of the letter were looked at, and when all the facts were taken into consideration, it could not be rightly said that this letter was intended to contain a binding promise. It might be described perhaps as an agreement to make another agreement, and, if so, it was not a promise which could be sued upon. Even if it were a promise at all, it was an independent promise, and could not be regarded as a condition precedent to the original contract. The plaintiffs were therefore entitled to succeed on all points. The plaintiffs' appeal would accordingly be allowed, and the defendants' appeal would be dismissed.

The Lords Justices delivered judgment to the same effect.

Electric Installation Company *v.* Lord Stratheden and Campbell.

This case, which on Saturday came before Justices Day and Wright, was an appeal by the plaintiffs from the decision of Mr. Ridley, the Official Referee, who had given judgment for the defendant both on the claim and counterclaim.

Mr. M'Call, Q.C., appeared for the plaintiffs; while Mr. Macaskie represented the defendant.

The plaintiffs sought to recover £1,300 for work done in connection with the fitting-up of an electric light installation at defendant's house, known as Hartrigg, near Jedburgh, and, after a hearing extending over eight or nine days, the Official Referee gave judgment for the defendant on the claim and also on his counterclaim for £300. The plaintiffs alleged that they were entitled to recover the amount of their claim with a certain deduction, the work having been done in accordance with the contract. The defendant, on the other hand, contended that the installation was deficient, because the water power which had been utilised was not nearly enough to produce the necessary light, and that he had had to incur a very heavy expenditure over and above that which plaintiffs had indicated would be necessary in order to make use of a brook of water to supply the necessary power for generating purposes. Plaintiffs complained that the Official Referee had refused to allow evidence to be called to show that the water power was sufficient within the meaning of the contract, and had decided the case upon the defendant's evidence.

When the case came on on Monday it was announced that the parties had come to terms, and that the appeal would be dismissed on the defendant paying to the plaintiff £750, without costs.

POOLE *v.* SOUTH.

THIS case, which had stood over from November 18th, came on for hearing at the City of London Court on Thursday last. It was an action brought originally by Poole & White, Limited, 58, Bread Street, Cheapside, in the High Court, against Mr. Harry South, of Garrick Street, Covent Garden, electrical engineer, to recover the sum of £37 7s. 10d. for goods supplied. The matter had been sent for trial to the City Court, and the learned judge had referred to the case, as being a matter of account, to the Assistant Registrar to be disposed of The parties had delayed obtaining an appointment for the hearing of the case for a period of four months from the last hearing on November 18th, and the items and facts in dispute dated back to 1892. Mr. J. Sims Williams was counsel for the plaintiffs, who now sued by Mr. Theodore Ellis, receiver and manager of the company. The items sued for were electrical switches and holders to the amount of £37 7s. 10d., dating from July, 1894. The defendant had filed a set-off for goods supplied to the plaintiffs in the shape of ball fittings, standards and lamp holders, and for allowance for returns, and special allowance on 620 lamp holders. He also claimed 2½ per cent. discount on £115 13s. 11d., the amount of goods supplied by him to the plaintiffs between certain dates. Counsel for defendant admitted the plaintiffs' claim, less an item of £5 12s. charged for a switch, which, although received from the plaintiffs in January, 1892, had been returned, as alleged by the defendant, in November of that year. On the other hand, counsel for the plaintiffs admitted the defendant's set-off, subject to the six last items of it, amounting to £25 4s. 4d. The defendant was unsuccessful in proving the return of the switch, and the Assistant Registrar said he must decide in favour of the plaintiffs as to that item, chiefly on the evidence of Mr. Alfred King, a former traveller in the employ of the plaintiffs, who swore that in 1894 he had seen the identical switch on the defendant's premises, and that he identified it as being a special article. He had asked defendant to allow him to take the switch back to have it cleaned up, but this was declined. The switch was supplied on sale or return in 1892. The plaintiffs' counsel cross-examined the defendant as to his set-off, and with regard to certain items of lamp-holders, ball fittings, with the result that no satisfactory evidence of either order or delivery of the four items was forthcoming. With regard to the claims for special allowance on the lamp-holders and 2½ per cent. discount on £115 13s. 11d., the evidence of the defendant himself, together with his witnesses, and the production of certain correspondence, satisfied the Assistant Registrar as to the legality of the demands. The plaintiffs' books were examined, and numerous letters and invoices produced and read. In the end the Assistant Registrar reported to the Court in favour of the plaintiffs for £17 10s. 10d., which amount, under the existing rules, deprives the now successful party of all costs.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

THE appeal in the matter of the Gülcher (New) Electric Light and Power Company, Limited, was on Thursday, last week, argued before Lords Justices Lindley, Kay, and A. L. Smith. Before Mr. Justice Vaughan Williams (see ELECTRICAL REVIEW, January 24th, 1896), the liquidator applied for a declaration that Mr. James Murray was liable to pay calls on 300 shares of the company. It appeared that Mr. Murray was the holder of some debentures which he agreed to exchange for preference shares on condition that 10s. per share was paid up on 37,423 shares. An allotment of the shares was made to him, and the liquidator sought to enforce that allotment. Mr. Justice Vaughan Williams held that the payment of 10s. per share on the 37,423 shares was a condition precedent to Mr. Murray's acceptance of the allotment, and dismissed the liquidator's application.

The liquidator now appealed, and after the case had been very fully argued on his behalf by Mr. Gore Browne, their Lordships, without calling upon Mr. Swinfen Eady, Q.C., who appeared for Mr. Murray, dismissed the appeal, with costs.

SANDON AND OTHERS *v.* THE CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED, AND FOWLER AND OTHERS *v.* SAME.

IN this case on Friday, the 27th ult., before Mr. Justice North, the defendants abandoned their application for the extension of time during which the injunction should be suspended, on the terms of paying the costs of the plaintiffs. Order accordingly.

BAILY & GRUNDY *v.* SMITH.

At the Cambridge County Court last week, the plaintiffs in this case secured judgment for 12s. 10d. for work done to a battery.

BUSINESS NOTICES, &c.

Business Announcement.—Messrs. Ward & Goldstone, owing to increased business, have taken, in addition to their works at Gorton, other premises at York Street Electric Works, Charles Street, C-on-M., Manchester.

Charge Dismissed.—At the Liverpool Assizes last week, Peter Bradley, electrician, was charged with embezzling sums of money from his employers, Messrs. Sharp & Kent. The jury, after hearing the case at length, found the prisoner not guilty and he was discharged.

Catalogues, &c.—Mr. A. W. Roy, of Heaton, Newcastle-on-Tyne, has issued a price list of very small dynamos, and materials for the construction of them, such as stampings, castings, shafts, &c.

Messrs. Cox-Walker, of Darlington, have sent us a catalogue of bells, telephones, indicators, presses, wires, batteries, &c. There is a large number of illustrations of these articles.

From Messrs. J. Sunderland & Co., of Halifax, we have received a catalogue of electric light requisites, including "Sundale" incandescent lamps, lampholders, ceiling roses, switches, cut-outs, wall-plugs, switchboards, arc lamps, small motors, wires, cables, &c.

Industrial Exhibition at Leicester.—On Saturday evening a Trades and Industrial Exhibition was opened at the Floral Hall, Leicester, by Sir Thomas Wright. The exhibits include gas engines, dynamos, signalling apparatus, and recent inventions in gas and electric lighting, and for the prevention of smoke.

Liquidation Notices.—A general meeting of the Foreign Electric Date and Time Stamp Company, Limited, will be held at the offices of Mr. Richard Warner, liquidator, 27A, Sackville Street, W., on Friday, May 1st, at 5 o'clock p.m., for the purpose of an account of the winding up being laid before the members.

The *London Gazette* notifies the release, dated March 24th, 1896, of Mr. C. J. Stewart, liquidator of Newington, Priddle & Co., Limited, 50, Great Sutton Street.

Clarke, Chapman & Co.—We learn that Messrs. Clarke, Chapman & Co., of Gateshead-on-Tyne, have, with Mr. Jos. Moore as their representative, opened an office at 73, Bridge Street, Manchester. Among the work which the firm have in hand at present in this district may be mentioned 7 400-light dynamos for Messrs. John Musgrave & Sons, Atlas Mills, Bolton, also a 1,300 light dynamo and 1,500 light installation for Messrs. Kilsall & Kemp, Rochdale.

Reduction of Capital.—Notice is given in the *London Gazette* that a petition presented to the High Court of Justice (Chancery Division) on March 5th, 1896, for confirming a special resolution reducing the ordinary share capital of Elmore's Patent Copper Depositing Company, Limited and Reduced, from £182,390 divided into 91,195 ordinary shares of £2 each to £91,195 divided into 91,195 ordinary shares of £1 each by cancelling paid up ordinary share capital which has been lost or is unrepresented by available assets to the extent of £1 per share on each £2 ordinary share, is directed to be heard before Mr. Justice Vaughan Williams on Wednesday, April 15th, 1896; any creditor or shareholder of the company desiring to oppose the making of an order for the reduction of the capital of the said company under the above Acts, should appear at the time of hearing by himself, or his counsel for that purpose. The solicitors are Messrs. Vincent & Vincent, 20, Budge Row, E.C., agents for North & Sons, 4, East Parade, Leeds, solicitors for the company.

Some Provincial Installations.—Two large and important buildings have been opened by the Duke and Duchess of York, *i.e.*, the new infirmary at Lancaster, and the new technical schools, Salford. Messrs. Drake & Gorham, through their Manchester branch, have just completed the extensive electrical arrangements in both establishments, the former installation consisting of some 300 lights, including medical switchboards, telephones, electric bells, and special electric cooking apparatus. The latter building has been fitted with a complete installation of nearly 1,300 lights, a number of high candle-power arc lamps, and alternating current motors for driving fans for ventilating purposes. The work has been carried out to a specification prepared by Mr. Charles Turner, the borough electrical engineer. The supply is taken from the Corporation electricity works, special transformers and controlling apparatus having been erected to transform the high pressure for lighting purposes. Messrs. Drake & Gorham's Manchester branch is at the present time engaged in carrying out the electric lighting of other large and important buildings, including the County Technical Schools, Stafford; the County Infirmary, Stafford; the Birkenhead Town Hall, as well as several private house installations, among which may be mentioned Greyfriars, for Mr. Frank Hollins, where there will be nearly 200 lights fixed; a separate plant consisting of petroleum engine, dynamo, and a set of D.P. accumulators and three Jandus 200-hour arc lamps will also be fitted.

The Vacuum Tube Company.—This company has been formed to meet the great demand that has arisen for vacuum tubes, owing to the recent development in photography, and has acquired certain patents in connection with the manufacture of tubes by a process securing higher exhaustion than can be obtained by any other known means. The company also supplies special scientific apparatus of any kind. For the convenience of medical men requiring to take photographs of patients by means of the "X rays," they have fitted up a room with a complete set of all the requisite apparatus, for the use of which a small fee is charged, inclusive of any desired assistance and advice. The address of the company is 39, Victoria Street, S.W.

The Jandus Arc Lamp.—We understand that although the works have only lately been in full swing, Messrs. Drake and Gorham have been able to deliver nearly 500 lamps. The firm is receiving excellent reports as to the performance of the Jandus lamp.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The gas engineers have reported regarding the proposal to extend the electric lighting system in the West End. It is proposed to extend the system to the Queen's Cross district, and to supply Golden Square and Rosemount up to the Bon-Accord Free Church. Other developments of the department are recommended, including increased accommodation at the central station in Cotton Street. The proposals entail a very large outlay.

Ambleside.—An Electric Light Company want an order to allow them to supply this district with electricity. The Board of Trade sent a communication to the District Council regarding the matter, and after discussion they have resolved to give "the assurance that they will undertake the production of the electric light themselves."

Battleship Lighting.—The first class battleship, *Mars*, launched on Monday from the yard of Messrs. Laird Brothers, of Birkenhead, is lighted throughout with an installation of about 900 electric lights, and equipped with six search lights of 30,000 candle-power, each of which is capable of being worked by dynamos under protection.

Belfast.—The electric light accounts are reported to be very satisfactory for last year, the working having resulted in a profit of about £300.

Bradford.—The Corporation publishes in the local Press a lengthy notice, required by their provisional order, of the resolution passed on the 10th ult. extending the area of electricity supply.

Bow and Poplar.—The Poplar District Board would appear to have been executing a dog-in-the-manger policy, for they have not introduced the electric light, and as the chairman of the Bow Vestry the other day said, they have efficiently protected the district against the introduction of the light by private companies. Enterprising private companies are not to be defeated by such a policy, thanks to the Board of Trade, and doubtless shortly some company will let the Council see that it cannot have things all its own way.

Bristol.—The Council is to be advised by a committee to borrow £75,000 for electric lighting extensions. There are now 510 customers, who have applied for 30,850 lamps, 490 customers having 28,134 lamps connected.

Cardiff.—Last week, at Cardiff, a Local Government Board inquiry was held regarding the Corporations application to borrow £12,500 for electric lighting extensions. The proposed outlay will provide for additional 10,000 8-C.P. lamps. 10,000 are now being supplied, and applications have been received for 2,500 more, which cannot be supplied.

Chelmsford.—Messrs. Crompton & Co. have furnished the Lighting Committee with plans relating to the proposed new electric light station, which the town has been asked to take over. Negotiations are still in progress.

Glasgow.—The inquiry regarding the state of electric lighting at Glasgow is progressing. In the course of their deliberations last week, the Electric Lighting Committee remitted to the electric light and gas inspectors the question of a very much wider lighting of the city by electricity, and to estimate the difference between the gas and incandescent electric light systems in lighting the subsidiary streets. Meantime, the operations for the experiment with overhanging lamps are proceeding with all speed. We hear that there was a general admission in the Committee that, having been among the first in the field with street electric lighting, Glasgow was suffering from initial blunders, which only practical experience could give them the means of remedying.

The chairman of Messrs. Howard & Wyndham, Limited, at the meeting held at Edinburgh on 26th ult., said that at the Theatre Royal, Glasgow, the directors found that the expense of the electric light from the Corporation was so great that it was impossible to continue it. They were making arrangements for an installation of their own.

Godalming.—The Electric Light Committee has instructed the engineer of Messrs. Fowler & Co., of Leeds, to report on eligible sites for an electric light station, and to furnish plans, estimate of cost of the works, &c. The Mayor and Mr. Page have been added to the Committee.

Grimsby.—The Public Lighting Committee has instructed the surveyor to prepare a rough sketch showing the extensions, &c., required, and an estimate of the cost. The sub-committee is to visit one or two towns and inspect electric lighting installations. An expenditure of about £40,000 is proposed.

Guildford.—The Electric Light Company have given notice that within a month they will commence to lay the mains.

Halifax.—The cost of installing the electric light at the Town Hall is £370.

Hampstead.—At the last Vestry meeting, Mr. Farmer asked when the work of lighting the High Road, Kilburn, by electricity would be taken in hand? If they were going to wait for Willesden, they might have to wait for ever. The chairman said that at present the Lighting Committee had no reference on the subject before them.

Ilfracombe.—Messrs. Tardrew & Son, of Bideford, have just fitted up an installation of the electric light at 6, Hillsborough Terrace, Ilfracombe, for Mr. Gabriel. The light is supplied from accumulators, which are charged by a dynamo at Messrs. Tardrew's factory.

Linlithgow.—Mr. J. D. Lovell has just had an installation of the electric light introduced into his paper works near Linlithgow. The work has been executed by Messrs. Loudon Bros., Dundee.

Liverpool.—On 26th ult. the first portion of the electric lighting scheme at the Landing Stage (the north end) was completed, and current turned on for the first time.

Newington.—Major Philip Cardew, R.E., held an inquiry on behalf of the Board of Trade at the Vestry Hall, Walworth Road, on Monday, to hear objections to the provisional order which is being promoted by the Newington Vestry. Among the opposers of the Bill are the London Electric Supply Corporation, the County of London and Brush Provincial Electric Lighting Company, Limited, and the Newington and Walworth Ratepayers' Association.

Peterborough.—After discussing the report of the engineer (Mr. Gill) to which we referred last week, the Lighting Committee being desirous not to settle the matter without the most careful consideration, has resolved to recommend the Council to take another canvass of the ratepayers before pledging itself to any definite course.

Shoreditch.—Several vestrymen, in company with the clerk and lighting inspector, visited the Portsmouth electric lighting station on 21st ult., and inspected the installation there.

South Africa.—The *British and South African Export Gazette* for April contains the following notes regarding electrical matters in South Africa:—Messrs. Macfarlane & Co. and Messrs. D. and T. Stewart & Co., Glasgow, have been successful in securing orders in connection with the installation of electric lighting in Durban. Messrs. D. Stewart & Co. have contracted to supply 6½ miles of 3-inch and 4-inch cast-iron electric mains (*sic*) and Messrs. Macfarlane and Co. will supply 60 arc lamp columns.—An electrical pumping plant is to be obtained for the unwatering of the Paarl Central mine.—Two generating dynamos have been ordered for the Princess Estate mine.—In addition to the motors mentioned in the February issue, electrical machinery is being obtained to supply power for working the new air compressor plant on the Sheba mine.—The electrical plant already at work on the Roodepoort Deep property is to be supplemented by a motor for hauling on the main shaft.—Mr. H. B. Venning, an electrical engineer who has been sent out from England, has been visiting the North Sheba mine for the purpose of selecting a site for the laying down of an electrical installation.—Mr. Venning has also visited the Sheba Queen mine for the same purpose.—A duplicate of the electric lift in the Royal Hotel, Cape Town, has been installed in the Grand Hotel of that city. The elevator is spacious and neatly upholstered, and the current is taken from the city mains.

The *African Review* says: "The preliminary operations in connection with the Rand Central Electrical Works Company are progressing actively. The short line of rails connecting the generating station on Brakpan with the "Rand Tram" will be completed in a fortnight or three weeks, and the transport of machinery to the station will thereby be facilitated. The cable which will convey the electrical power from Brakpan to the various mines until the farm Paardekraal is reached is being put down, and the necessary buildings are being erected."

Wallasey.—Notice is filed in the *London Gazette* of the electric lighting provisional order for which the District Council is applying to the Board of Trade.

Windermere.—The Highways Committee recommends that some new lamps which are being erected at Troutbeck Bridge be lighted by electricity, as the gas supply there is defective.

West Ham.—After the Town Council had passed a resolution advertising for an electrical engineer at £300 per annum, an endeavour was made to pass a resolution instructing the Highways Committee to ask upon what terms the eight contractors tendering for the work will be willing to maintain the installation for a term of seven years, as an alternative to handing it over at the expiration of 12 months. The motion, however, was lost.

Yarmouth.—Messrs. Crampton & Co. have received instructions for the installation of the electric light to the extensive new stores on the North Quay.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Another Electric Traction Scheme Likely to be Dropped.—The *Kidderminster Shuttle* says that there is some probability that the Bill now before Parliament for an electric tramway between Kidderminster and Stourport may be dropped, at least for the present Session. It has passed the second reading in the House of Lords, and is now before the Committee, where it is found that the modifications introduced are of so extensive a nature that, according to the standing orders of the House, amended plans and sections are required to be deposited with the Clerk of the Peace and the various local authorities, and notices served very much in the same way as if the Bill were promoted *de novo*. Although considerable preliminary expense has been incurred, the promoters state they will have to abandon the Bill for the present if the County Council, the Kidderminster Town Council, and the Stourport Urban Council continue to insist upon the bulk of the alterations they have asked for.

Belfast Tramways.—The Corporation the other day held a special meeting to consider the application of the Belfast Street Tramways Company for an Order in Council authorising certain tramways. The order included powers for the doubling of the lines and using electricity as a motive power. The Corporation adjourned further consideration of the matter for a fortnight.

The deputation which recently visited various cities and towns

where electric traction is employed has prepared its report. It deals in detail with the visit to English and Continental towns, and describes the system in each. The systems of Dublin, Kingstown, Bristol, Havre, Paris, Brussels, Hanover, Hamburg, Berlin, Dresden, Vienna, Buda Pesth, and Birmingham are detailed, and the report concludes with the statement that the deputation has come to the conclusion that electrical traction, under certain conditions, is best suited to the wants of the public and the requirements of the city. The overhead wire system is recommended, the conditions to be observed in making such a conversion being enumerated at length in 13 paragraphs.

Cardiff Tramways.—A proposal is being made here by Councillor Tucker, having in view the purchase of the tramways by the Corporation, extensions to be afterwards carried out, and electrical power to be used whenever the Corporation think it advisable. A sub-committee of the Tramways Committee has been appointed to consider the whole question.

Cork Tramways.—The Cork Tramways Company have approved of the agreement between themselves and Mr. Murphy, whereby they agree to assign and transfer to the Cork Electric Tramways Company the powers granted under their Privy Council Order, for constructing certain tramways. Mr. Murphy is to pay £1,000 to the Company for the order to cover expenses.

Electric Power at Barberton.—Messrs. Easton, Anderson & Goolden, Limited, as the successors of Messrs. W. T. Goolden and Co. (the contractors for the electrical transmission plant at Moodie's Gold Mining Company), have written to the *Financial News* with reference to the letter from Mr. W. B. Esson, which we reproduced in our last issue. They cordially endorse Mr. Esson's views as to the reliability of electricity as a motive power in mining and other districts. "Having supplied electrical plants to many mines, both at home and abroad . . . . we feel that we are in a position to speak with authority on the subject. To supply, however, any plant, whether the motive power be electricity, steam, or anything else, it is necessary to know beforehand the conditions under which it is to work, and the amount of power required. Neither of these factors were known in the case of Moodie's. The calculations as to the quantity of power required were prepared at Barberton, and embodied in a specification, and the plant supplied by Messrs. Goolden & Co. was designed to produce, and, in fact (as certified by Moodie's consulting engineer), produces the quantity specified. It now turns out that these calculations were quite incorrect, and that the quantity specified is altogether insufficient for the work required. Thereupon the uninitiated hasten to fall foul of electricity as a motive power, forgetting that as they cannot expect 50 H.P. out of a 5-H.P. steam engine, so they cannot hope to extract from a dynamo or motor more current than it is constructed to supply. They should address their complaints to the gentlemen who are responsible for the miscalculations in question, and not to the contractors who supplied exactly that which they were asked to supply."

Madras Electric Tramways.—The construction of the Madras electric tramway is making progress, the third section having just been completed and opened for traffic. This section of the line is on the overhead conductor system.

Proposed Electric Tramway.—It is stated that a project is on foot to establish an electric tramcar system connecting Norton, Stockton, Thornaby, and Middlesbrough. The existing interests of the Imperial Tramway Company in Middlesbrough would be acquired, a connecting line from Middlesbrough to Thornaby laid, and the Thornaby, Stockton, and Norton interests of the Darlington and Stockton Tramway Company (the affairs of which are in Chancery) acquired in those places. The District Fund Committee of the Stockton Corporation, however, object to the proposed overhead electric system, and if that Corporation will not grant the requisite permission, the operations of the combination will be confined to Thornaby and Middlesbrough.

The Mersey Railway and Electricity.—The Parliamentary Committee of the Birkenhead Council have decided that no further action shall be taken in opposing the Bill introduced by the Mersey Railway Company, a clause in which relates to the utilisation of electricity as a motive power by the company.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
" " (P.Q.) ...	June 24th, 1895 ...	...
Brest-Penzance (P.Q.)	... ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Santarem-Manaos	Mar. 27th, 1896 ...	March 28th, 1896
Assab-Massowah. Telegrams between these places are forwarded by special boat ...	March 29th, 1896 ...	...
Landlines.		
Communication with Matagalpa Provinces of Leon and Chinandega ...	Feb. 26th, 1896 ...	...
Trans-Continental line beyond Mazol (Mashonaland)		
Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...

Newcastle Telephone Service.—On 31st ult. the National Telephone Company formally inaugurated a new exchange they have established at Pilgrim Street, Newcastle.

Telegraphs in the Malay Peninsula.—At a special meeting of the members of the Royal Colonial Institute, held at the Royal United Service Institution on Tuesday last, Mr. F. A. Swettenham, C.M.G., stated that there was considerable progress being made in the extension of telegraphs along the west side of the Malay Peninsula. They would in time join the Burmese lines now at Merjui. This line will provide another route, *via* Burmah to India, and should be of vital interest to the projectors of the Pacific cable route to Australia as providing them with another means of strengthening the lines of communication between Great Britain and India over British territory.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 1st. The municipal authorities of Prague are inviting tenders for the erection of and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes. Tenders are to be directed to the Stadrath der Haupt, Stadt Prague, Prague, Austria, from whom full particulars may be obtained.

Austria.—April 15th. Tenders are invited for the supply of 2,246 cast-iron pipes varying from 100 to 400 mm. in diameter, required during the present year for the extension of the telephonic system in Vienna. Tenders are to be directed to the K. K. Postund Telegraph Direction, Abtherlung XIII., Vienna.

Bedford.—April 4th. Tenders are being invited by the Electric Light Committee for the supply and erection of one 240 B.H.P. double-acting compound enclosed engine, and one 150-unit alternator, with stationary armature. Specifications, &c., may be obtained at the offices of Mr. T. S. Porter, Clerk to the Urban Sanitary Authority, Town Hall, Bedford. See our "Official Notices."

Bradford.—April 8th. The Corporation is inviting tenders for erection of a building required for the new electricity station at the junction of Valley Road and Lionel Street in the borough. Details on application to Mr. Thomas Barker, A.M.I.C.E., architect, at his offices, 5, Bond Street, Bradford.

County Antrim.—May 1st. The Commissioners for the control of Lunatic Asylums invite tenders for the supply and erection of an electrical installation at County Antrim Lunatic Asylum.

Derby.—April 13th. The Corporation wants tenders for the supply and laying of low tension cables and junction boxes in the borough. For further details see our "Official Notices."

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

France.—April 9th. The municipal authorities of Paris are inviting tenders for the supply of eight candelabras required in connection with the electric lighting of the Quais de Jemmapes et Valmy. Tenders to be sent to the Hotel de Ville, Paris.

Harrogate.—April 7th. The proprietors of the Prince of Wales Hotel want tenders for an electric light installation (about 400 lights) including generating plant, also telephone and bell installations. Further details will be found in our "Official Notices."

Lima.—June 1st. The Municipal Council is inviting tenders for the establishment and working of the electric lighting in the squares and streets of the city, with power to work the private supply under a 20 years' contract. Particulars to be obtained at the Peruvian Legation, 13, Comeragh Road, West Kensington, W.

Peru.—June 1st. The Municipal Authorities of Lima, Peru, are inviting tenders for the concession for the electric lighting of the city. Tenders are to be directed to La Legation de Perou, 8, Avenue Hoche, Paris, from whom particulars may be obtained.

Shoreditch.—April 14th. The Vestry invites tenders for engines, dynamos, pumps, mains, transformers, accumulators, &c., for the generating station. Specifications, &c., from Messrs. Kincaid, Waller, and Manville, 29, Great George Street, Westminster. See our "Official Notices."

Wallasey.—April 6th. The District Council is prepared to receive tenders for the undermentioned works, viz.:—*a*, Steam alternators, switchboard, and accessories; *b*, High and low tension concentric cables; *c*, Transformers. Particulars may be obtained on application to the Engineer, Mr. J. H. Crowther, at the Gas and Water Works, Great Float, near Birkenhead. See our "Official Notices."

CLOSED.

Aberdeen.—The Gas and Electric Lighting sub-Committee has agreed to accept the offer of Crompton & Co., Limited, London, to supply for £2,600 a new 300 H.P. engine and dynamo for the Cotton Street station. Messrs. Siemens Bros. are to furnish additions to the switchboard for £130.

Bedford.—The District Council is entering into a contract with Messrs. Siemens Bros. & Co., Limited, for the construction of a switchboard, including the supply of necessary instruments for £400; and with Mr. W. Bradley, for the supply of 150 additional cast-iron lamp standards and fittings for £374 5s.

Burnley.—The Gas and Electric Lighting Committee has accepted the tender of Messrs. S. Z. de Ferranti, Limited, for the supply of 50 electrical meters at a cost of £262 10s.

Shoreditch.—Tenders have been received as follows by the County Council for electrically lighting certain parts of the new fire engine station in Tabernacle Square, and that of Messrs. Russell and Lennard is recommended for acceptance:—

Russell & Lennard	£173 15 0
Drake & Gorham	186 5 6
Crompton & Co., Limited	219 0 0
Pritchetts & Gold	228 0 0
A. W. Jackson	248 10 0

St. Helen's.—For the erection of engine, machine rooms, &c., for the electric light works, the tender of Mr. Wm. Molyneux has been accepted by the Lighting Committee.

West Kirby.—Messrs. G. Ewing Johnston & Rea, of Liverpool, have secured the contract for laying down a complete electric lighting plant, consisting of gas engine, dynamo, accumulators, incandescent lamps and fittings at the New West Kirby Hydropathic.

NOTES.

Personal.—Mr. H. J. Dowsing has resigned his appointment as Manager of the Electrical Heating and Cooking Department of Messrs. Crompton & Co., Limited, and has taken offices at 24, Budge Row, Cannon Street, E.C., where he will carry on the business of electric heating, adding several other special departments in the application of electricity. Mr. Dowsing has been nearly 15 years connected with Crompton & Co., first on the outdoor staff, then London Office manager, and finally manager of the Heating Department, which he established, the patents covering the processes bearing his name in conjunction with that of Mr. Crompton. Mr. Dowsing will be pleased to place his experience at the disposal of those about to adopt electric heating, and he will give special attention to the requirements of electric supply companies.

Mr. James Trackson, of the commercial department of Messrs. Trackson Bros., of Brisbane, is leaving there by the ss. *Rome* on a visit to Europe, and hopes to be in London during the month of June. All communications for Mr. Trackson should be addressed to the Electrical Review office.

Hochspannungsakkumulatorenbatterie.—The above is another little German gem which we notice in a contemporary. To solve it, it must be taken in instalments; the real beginning is near the end, and the real end is the beginning; but this rule is not followed strictly, for if it were, it might be more convenient to read it by means of a mirror. Begin near the end, then start again near the middle, and continue this oscillating process until all the letters and syllables have been interpreted, being careful to get the right combination. The interesting part of the solution is to find the correct separation between the individual words, which are not separated by hyphens, presumably to save trouble (in writing, not in reading). For instance, this word has nothing to do with the following words, although they form parts of it: Ochs (German for ox), span, pan, sak, oren (German for ears), renn (running), bat, batter or Erie, although these words taken together might suggest an interesting little story. The correct solution is as follows: A battery of accumulators whose voltage is high.—*Electrical World* (N.Y.).

Anthracite Coal.—Anthracite coal has given a great deal of trouble in its day by the burning out of grates, and on locomotives the water grate is almost universally used where this coal is burned. The reason, says *Dixie*, lies in the fact that the coal holds its heat, and after being raked down burns brightly at the bottom of the bed for a long time, thus serving to melt the grates. The purer the anthracite the more difficult it becomes to keep the grates in working condition, so that where we get the run-of-men firemen, it is actually more economical to burn a poor coal than one of good quality. The ash and slate that the latter contains is quickly deposited over the bars, protecting them from the too intense heat of the coal above. Anthracite requires care in the firing, and greater care in the raking down, lest we have a fire both above and below the grates, causing their speedy destruction.

The Institution of Junior Engineers.—The *conversazione* of this Institution, which, although young, is rapidly assuming a position of importance in the engineering world, took place on Saturday evening last, at the Westminster Palace Hotel, the guests being received by the president, Mr. Archibald Denny, the chairman, Mr. H. Young, and Miss Young. Exhibits of the theatrograph by Mr. Robert W. Paul, the Edison-Bell phonograph by Mr. and Mrs. Lynd, and of the Wimshurst machine by its inventor, formed, perhaps, the most popular features of the evening's entertainment, the last-named being a never failing source of attraction, and also, paradoxical as it may seem, of repulsion, when such charged bodies as Mr. Denny and Mr. J. Macfarlane Gray began to spark in all directions. Through the courtesy of the National Telephone Company and of the Electrophone Company, 16 instruments were simultaneously available for hearing popular selections from no less than eight places of amusement. Lovers of the divine art were amply catered for in a lengthy programme of music performed by Mr. W. M. Day's capital band, and two short vocal and instrumental concerts. A number of most interesting exhibits of electrical apparatus was provided by the India-Rubber and Gutta-Percha Company, Messrs. Crompton and Co., Mr. James White (Lord Kelvin's instruments), Mr. Robert W. Blackwell, Lord Armstrong, Messrs. Elliott Bros., Messrs. Nalder Bros., the New Phonopore Telephone Company, Mr. C. E. Spagnoletti, Messrs. Saxby & Farmer, the Postmaster-General, the Electric Welding Company, and the Otis Elevator Company, while a great variety of other apparatus connected with engineering industries was also on view. Mr. A. A. Campbell Swinton's original lantern slides and photographs produced by the X ray were also shown, and the new photography was demonstrated by Messrs. Leslie Miller and Mr. P. Marshall. The large number of guests must have been highly pleased with the attractions got together for their edification, and we congratulate the Institution on a distinctly enjoyable and successful *conversazione*, and also the secretary, Mr. Walter T. Dunn, on the results of his untiring efforts.

Röntgen Rays.—Prof. Oliver Lodge puts it on record in the *Times* that during the past 10 days he has seen fluorescence excited by Röntgen rays after they had penetrated the bodies of two men, standing one behind the other, in their clothes. Also he and his co-workers have succeeded in radiographing the details of a damaged vertebra in the spine of an adult patient at the Northern Hospital, Liverpool, with an exposure of half an hour, and have found a "Murphy-button" in the intestine of another adult at the Liverpool Royal Infirmary with an exposure of 10 minutes. A focus tube and a powerful ordinary induction coil were the means used.

At the Reading Town Hall, on 26th inst., Mr. Charles E. Phillips, A.I.E.E., lectured on the "X" rays. Dr. Shettle presided.

The Queensland Vacancy.—We learn from a contemporary that there has been a small crowd of competitors for the appointment of electrical engineer to the Queensland Government. Mr. Dicken, C.M.G., the acting Agent-General for the Queensland agency, has been busy with Mr. W. H. Preece in winnowing out the applications from about 70 first-class competitors.

The British Association Meeting, 1896.—The members' circulars for this year's B.A. meeting are now being issued, so that the necessary arrangements for the number intending to be present at Liverpool from September 16th to 23rd may be made. The names of presidents of certain sections are as follows:—

Section A.—Mathematical and Physical Science. Prof. J. J. Thomson, M.A., D.Sc., F.R.S.
Section B.—Chemistry. Ludwig Mond, Esq., Ph.D., F.R.S., &c.
Section G.—Mechanical Science. Sir Douglas Fox, M.Inst.C.E.

Honours for Röntgen.—We learn from an American source that Prof. Röntgen has been created a Baron by Prince Ludwig of Bavaria, and has also been decorated with the Order of the Royal Crown by the Kaiser Wilhelm.

The Miner's Inch.—A New York exchange, in reply to a correspondent a few weeks ago, stated that, in engineering phraseology, there is no term for the rate of flow of one gallon per second, which would be the analogue of the ampere. Prof. T. O'Connor Sloane has since written stating that this assertion is incorrect, inasmuch as the *miner's inch* is a perfect analogy for the ampere. The head of water represents the E.M.F. the aperture, the resistance, the rate of flow (the "miner's inch"), the ampere. The editor, in acknowledging the correction, says the miner's inch, by which water supply for hydraulic mining and irrigation purposes is very largely measured in the Western States, is the rate of flow that will take place through an orifice in a vertical surface 1 inch square, under a constant head. It is therefore an exact analogy to the ampere.

What is an Electro-Magnet?—We must credit Mr. W. Perren Maycock, whose letter appears in our "Correspondence" columns, with a good deal of ingenuity in his definition of an electro-magnet; but then Mr. Perren Maycock has had considerable experience in dealing with examination questions. But for plain people, who are content to call a spade a spade, or something worse, the following definitions may be of some assistance. Dr. Silvanus Thompson, in the preface to his work on "Electro-Magnets," defines an electro-magnet as an "iron core surrounded by a copper wire coil." Sloane, in his "Standard Electrical Dictionary," gives "Electro-magnet—a mass, in practice always of iron around which an electric circuit is carried, insulated from the iron." Further, Houston gives "Electro-magnet—a magnet produced by the passage of an electric current through a coil of insulated wire surrounding a core of magnetisable material."

The Lighting of the Hotel Cecil, Victoria Embankment.—In connection with the recent competition for electric light fittings for this large building, which is now approaching completion, Messrs. B. Verity & Sons were successful in securing the whole order for these. The ground floor is being decorated in the "Empire" style, which again appears to be coming into fashion, and Messrs. Verity submitted a special set of designs of Empire electric candelabra and other fittings for these rooms. They sent in about 240 different coloured drawings, many of which were designed specially for this competition, and six draughtsmen were employed by them on the work for over five weeks.

Accidents Due to Gas.—On 22nd ult., a serious gas explosion wrecked the shop premises of Mr. J. Samuel, at Nantwich, and severely injured the proprietor and his daughter.

Not many weeks ago a fatality occurred at Cheltenham in one of the electric lighting sub-stations. Now we have to record an even more serious accident at the Cheltenham Gas Works, which occurred on 19th ult., blowing one man to pieces and seriously injuring two others.

At Hengoed, near Cardiff, a terrific explosion (stated to be due to gas), occurred. Walls were destroyed, and the roof considerably damaged, the shop front blown into the road, &c., the occupant and his assistant being seriously injured.

Dr. Herz.—The French Government has withdrawn its application for the extradition of Dr. Herz on the charge of *abus de confiance* and *escroquerie*, and has applied for his extradition only on the charge of threats, by letter or otherwise, with intent to extort. A fresh warrant has accordingly been issued, and on Friday, 17th inst., Sir John Bridge will hear the case at Bournemouth. Sir George Lewis, solicitor to Dr. Herz, has replied that fatal consequences might ensue from subjecting the doctor to the ordeal of an examination.

The Dynamo Cycle.—In the leaderette which appeared in our issue of March 6th, the first use of this application of the bicycle to home training and electric lighting should have been attributed to Mons. Henri Serrin, not Henri *Servi* as stated.

Lecture.—Before the Bristol Association of Engineers recently, Mr. H. Faraday Proctor read a paper on "The Electric Lighting in Bristol."

The Importance of being Exact.—A correspondent writes:—"Though many people decry the importance of a great change by wondering why no one has done it before, the 200-volt movement is almost an accomplished fact, and one is tempted to think that the very argument used to diminish the important sound of the change is one of the best in its favour. Many of the most successful ideas, or inventions which have been brought out in recent times give rise to the remark, 'Why have we never done it before.' Still, some points require the grave consideration of the engineer, who has to reconcile the somewhat complex connections of coal bill, general expenses, station meter readings, and sum of customers' meter readings brought in by inspectors, which bring in revenue, and not the least of these is the reading of the voltmeter used to regulate the pressure. How many stations does one see where there are many, and very various, voltmeters? and the authorities may tell one—Well, that instrument you are looking at is all right in the mornings, but we can't use it when there is a big current through the bus bar at the back of the board. Though it is true that the higher our working pressure is raised the more we become independent of differences of small degree, much in the same way that the double bass player told the enquiring violinist, 'lor bless yer, we ain't particular to an inch or two.' Still, gradually but surely, and very rightly, our 'practical' men are coming round to the idea that absolute values govern all things in matters electrical, just as in supply of gas, water, or other common or domestic stuff. The days when a Brush arc lighter could be dumped down out of a cart, belted up to an engine on one side, and wired to a series of arcs on the other—the speed being principally determined by the appearance through spectacles of the station arc, and the comparatively steady burning of the circuit ones, are gone for ever, and watts output per ton of coal burnt, per pound of cotton waste used, and per £100 invested in plant, are daily considerations, and this is where the question of the accuracy of the station instruments, and especially the station voltmeter, comes in."

Patent Litigation in the U.S.—Scarcely an issue of the American electrical press comes to hand without a report of some expensive legal suit which has been fought there regarding electrical patents. Perhaps the two companies which have figured in this litigation more than all others have been the General Electric Company and the Westinghouse Electric Company. It is therefore with considerable satisfaction that we understand from the New York *World* that these two gigantic companies have come to an agreement, whereby further litigation regarding patent matters will be avoided, millions of dollars being thus saved in lawyer's fees. The unfriendly relations of the two companies naturally led to undercutting and the other ruinous effects of unhappy working. The effect of the agreement was felt in Wall Street, and if the *World's* statements are correct, competition is expected to be stopped, and the prices of dynamos, motors, and electrical appliances, as supplied by both concerns, will be raised.

India-Rubber v. Gutta-Percha.—In the *India-Rubber World* for March 10th appears an article entitled "The Use of Gutta-Percha in the United States." The writer quotes from a pamphlet issued by a gutta-percha company in the early fifties a number of comparisons between the two crude materials, two of which read as follows:—

India-rubber is a conductor of heat, cold and electricity.
Gutta-percha is a non-conductor of heat, cold and electricity.
India-rubber is not a perfect repellant of water, but is more or less absorbent, according to quality.
Gutta-percha has an oily property, and is a perfect repellant of water.

It seems that in those days a belief existed that G.P. was destined to drive I.R. out of the market.

London Chamber of Commerce.—The report, which was adopted at the annual meeting of this Chamber on Monday, contained reference to inquiries made in the City regarding proposed telephonic communication between London and Holland, which it has been found would not pay. The report also refers to the question of autocars, and contains a *resumé* of what the Electrical Trades Section has done during the year.

NEW COMPANIES REGISTERED.

New General Traction Company, Limited (47,321).—This company was registered on March 24th, with a capital of £170,000, in £5 shares (10,000 preference), to adopt an agreement with E. A. King, and to carry on the business of contractors for the construction and equipment of railways and tramways with electrical or other mechanical power and of public works of all kinds. The subscribers are:—E. A. Hopkins, 35, Parliament Street, S.W., gentleman, 1,000 shares; A. Jones, 166, Maygrove Road, Hampstead, accountant, one share; H. Soinks, 59, Church Road, Homerton, clerk, one share; E. A. King, 297, Winchester House, E.C., gentleman, one share; E. T. Church, 41, Copleston Road, Denmark Park, clerk, one share; J. Alexander, 146, Upland Road, East Dulwich, accountant, one share; G. A. J. Smallman, 90, Wightman Road, Hornsey, gentleman, one share. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification £250; remuneration £100 each per annum and a share in the profits. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

Britannia Motor Carriage Company, Limited (47,332).—This company was registered on March 24th with a capital of £100,000, in £1 shares, to adopt an agreement with J. Ashton to acquire certain patents, and to carry on business as electricians, cycle motor and carriage manufacturers, engineers, machinists, fitters, founders, wire drawers, &c. The subscribers (with one share each) are: F. Sidney, 98, Sewardstone Road, Victoria Park, clerk; A. North, 2, Church Court, Clement's Lane, E.C., clerk; H. Hick, 3, Montague Place, W.C., clerk; E. W. Little, 325, Stanstead Road, Catford, book-keeper; O. L. Richardson, 113, Roman Road, Barnsbury, clerk; G. Watts, 74, Union Road, Rotherhithe, clerk; H. Edwards, 110, Cannon Street, E.C., secretary. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; qualification, £100; remuneration, £100 each per annum, and £50 extra for the chairman. J. Ashton is the managing director, with £500 per annum. Registered by W. T. Hick, 2, Church Court, Clement's Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's annual return was filed on March 11th. The capital is £350,000, in £5 shares (50,000 ordinary, 10,000 first preference, and 10,000 second preference). 15,000 ordinary, 10,000 first preference, and 2,500 second preference have been taken up, and 5,000 ordinary are considered as paid. £5 per share has been called on the rest, and £112,500 has been paid.

London Electric Supply Corporation, Limited (24,957).—This company's annual return for 1895 was filed on February 26th last. The capital is £1,250,000, in 200,000 ordinary and 50,000 preference shares of £5 each. 111,000 ordinary and 48,050 preference have been taken up, and £5 per share called. £798,990 has been paid on these, and £3,740 received in respect of 1,950 forfeited shares.

National Electric Supply Company, Limited (29,992).—This company's annual return was filed on March 5th. The capital is £100,000, in £5 shares (100 founders'). All the founders' and 10,550 ordinary have been taken up, the full amount called, £53,235 paid, and £15 unpaid.

Municipal Electric Light and Power Corporation, Limited (29,091).—This company's annual return was filed on January 22nd. The capital is £25,000, in 2,490 £10 ordinary shares, and 100 £1 founders' shares; 37 ordinary and 30 founders' have been taken up, the full amount called, and £400 paid.

Northampton Electric Light and Power Company, Limited (28,640).—This company's annual return was filed on March 14th. The capital is £50,000 in £1 shares (of which 10 are "A" and the rest "B"). Ten "A" and 13,200 "B" shares have been taken up, and £1 per share called and paid on the "B" shares. No calls have been made on the "A" shares.

Miners' Lamp Electric Lighting Company, Limited (28,019).—This company's return was filed on March 2nd; the capital is £3,000 in £5 shares; 301 have been taken up, and 190 are considered as paid; £5 per share has been called on the rest, and £550 has been paid, leaving £5 unpaid.

General Electric Company, Limited (29,433).—This company's annual return was filed on March 10th. The capital is £85,000, in £5 shares (of which 7,000 are first preference, 1,000 second preference, 4,000 ordinary, and 5,000 third preference. 12,925 shares have been taken up, and 4,000 ordinary and 1,000 second preference are considered as paid. £5 per share has been called on 7,925 shares, and £39,625 has been paid.

Gordon Electric Traction Syndicate, Limited (32,227).—This company's annual return was filed on January 4th. The capital of £2,400 has all been taken up, and 60 £10 shares are considered as paid. The other 180 shares have been paid for in full.

Madras Electric Tramways Company, Limited (36,158).—This company's annual return was filed on January 23rd. The capital is £100,000, in £1 shares; 60,669 shares have been taken up, and 7,760 have been issued as paid; £1 per share has been called on the others, and £57,652 17s. 10d. has been paid, including a sum of £4,743 17s. 10d. paid on 8,584 forfeited shares.

Mazarron Electric Light Company, Limited (38,277).—This company's annual return was filed recently. The capital is £15,000 in 500 preference shares of £10 each, and 10,000 ordinary shares of £1 each; 151 preference and 10,000 ordinary are taken up, and 9,993 ordinary are considered as paid. The full amount has been called on the preference and seven ordinary shares, and £1,517 has been paid.

Lynton and Lynmouth Electric Light Company, Limited (41,835).—The annual return of this company was filed on January 1st. The capital is £8,000 in £1 shares (of which 1,000 are preference); 1,000 preference and 2,908 ordinary have been taken up, and 1,000 preference and 2,900 ordinary have been considered as paid. £8 has been paid on the rest.

Improved Electric Glow Lamp Syndicate, Limited (45,815).—This company's statutory return was filed on March 12th. The capital of £5,000, in £1 shares, has been taken up, and 1,318 shares are considered as paid. £3,682 has been paid on the remainder.

CITY NOTES.

Willans and Robinson, Limited.

The recently issued report records one of the most successful year's work ever accomplished by the Thames Ditton firm. The horse-power of engines ordered show substantial increase, but even this bids fair to be eclipsed by this year's commissions, seeing that orders for 22,200 H.P. have been received during the first three months of 1896. A dividend of 7 per cent. is maintained on the ordinary shares. It would be obviously unfair to criticise the cost of production in the present transitory state of the company's affairs. The fourth half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at 3 p.m., on Wednesday, April 8th, 1896, states that:

"The company's business continues to develop in a thoroughly satisfactory manner. Although, for reasons explained in previous reports, new business has been little sought for, the horse-power of Willans engines ordered in 1895 was 27,883, against 26,624 in 1894; these figures compare, it will be remembered, with 18,950 horse-power in 1893, the last and best year of the old company. Even more significant is the fact that in less than three months of 1896, the horse-power ordered has reached 22,200, a development which, if more or less exceptional, yet indicates the probability of a rapid growth of business in the future. The results of the half-year's work have been as satisfactory as in any previous period, notwithstanding that the operations of the company have been hampered, even more than before, by inadequate, and therefore uneconomical means of production. After writing off as depreciation from plant, patents, &c., the sum of £3,769 13s. 14d., the balance to the credit of profit and loss account for the half-year (including £319 10s. 2d. brought forward from last half-year) is £11,832 14s. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum (as before) upon the ordinary shares, together amounting to £7,224 19s. 5d. The amount payable to the directors, in accordance with the articles of association, is £1,286 9s. 4d., and it is proposed, as on the last occasion, to carry £2,500 to the reserve fund. The balance, £821 5s. 3d., it is proposed to carry forward. By the proposed appropriation the reserve fund, as the result of the first two years' working, will reach £7,646 9s. 11d., and of this sum the year 1895 will have contributed £5,000. The new works at Rugby are not yet in a position to assist in the production of engines, partly through delay by the contractor for the structural steel work; partly from the necessity which has already arisen for extending the new buildings, and for commencing others which it had been originally intended to defer, the directors having judged it advisable to prepare for manufacturing operations at Rugby on a larger scale than was contemplated at the date of the last report. A number of the lighter new machine tools, intended eventually for Rugby, have been installed in a temporary building near Thames Ditton, where they are doing excellent service. The necessary authorisation for the contemplated issue of debenture stock should now be given, and a resolution will be submitted to the meeting to that effect. In view of the remarkable expansion of the business, and of the necessity which may arise for even further extensions at Rugby, the directors think it will be prudent to take powers to borrow up to the limit allowed by the articles of association, viz., £112,500, but, so far as they can foresee at present, an actual issue of £75,000 may suffice. The exact conditions will be best left for settlement when the issue is made, but there is every reason to believe that the company will be able to place the stock upon favourable terms. The mortgages upon the Thames Ditton freeholds have been paid off. The auditors, Messrs. Cooper Brothers & Co., retire, but are eligible for re-election."

County of London and Brush Provincial Electric Lighting Company, Limited.

The directors' report (of which we published an abstract last week), to be presented to the shareholders at the second ordinary general meeting of the company, to be held at Winchester House, Old Broad Street, London, E.C., at 2 o'clock, p.m., on Monday, April 13th, 1896, states that the capital expended during the year on the London

stations, as per statements A. and B., amounted to £92,151 10s. 9d.; the investments in shares and debentures of, and the sums advanced to associated companies, amounted to £73,396 5s. 10d.; total £165,547 16s. 7d. This expenditure has been met by instalments falling due on ordinary shares, and by the issue of 10,000 6 per cent. preference shares at par, mentioned in last year's report, which were applied for several times over, and now stand at a substantial premium. The balance to credit of revenue account for the past year, after payment of proportion of rents, rates, taxes and general establishment charges, amounts to £2,714 7s. 9d.; to which must be added £332 5s. 10d., brought forward from 1894 account, making a total of £3,046 13s. 7d. Out of this sum an interim dividend for the half-year ending June 30th, 1895, at the rate of 6 per cent. per annum on the preference shares, was paid on July 15th last, and the directors recommend that a further dividend to December 31st, 1895, at the same rate, be paid upon the preference capital. This will leave a balance of £1,208 19s. 1d. to be carried forward to next year's account.

County of London.

St. Luke and Clerkenwell.—In the St. Luke and Clerkenwell districts the cables required for the compulsory streets have been drawn in, and the transformer sub-stations have been constructed; but owing to a strike of contractor's workmen, much delay has taken place in the completion of the generating station. Applications have nevertheless been received for the equivalent of 7,000 8-C.P. lamps, of which 5,700 are now connected to the company's mains, and the directors anticipate that there will be a sufficient number of lamps applied for by the time the station is completed, to ensure a profit being earned from the commencement of working the plant.

Wandsworth.—In the Wandsworth district the company's operations have been materially retarded, owing to objections having been taken by the local authority to the construction of transformer boxes in the streets. All questions have now, however, been satisfactorily arranged, and the generating station on the Wandle will soon be completed. The conduits for cables have been laid throughout the district, cables are being drawn in, and it is expected that about September next current will be available along the route of the company's mains for all consumers who may then have applied for connection.

St. Olave.—In the St. Olave district, to which reference was made in last year's report, the provisional order was granted by the Board of Trade; owing, however, to the dissolution of Parliament it was not confirmed last session. It will come up for confirmation in the present session.

Other London Districts.—The company has also applied to the Board of Trade for a provisional order for other areas in South London, and has received the consent of the Camberwell vestry to the granting of an order for the district within its jurisdiction. The company will be in a position to supply the parishes of St. Olave, St. George the Martyr, and Camberwell from one generating station.

Provinces.

The Bournemouth and District Electric Supply Company, Limited.—During the past year the Bournemouth Company's station has been completely remodelled and enlarged, and additional plant and mains have been laid. That station has now plant capacity for 27,500 8-C.P. lamps, and the equivalent of 21,000 8-C.P. lamps connected.

The Dover Electricity Supply Company, Limited.—The work of laying mains and equipping the Dover Company's station was completed last year, and an uninterrupted supply of current has been given since April, 1895. Referring to the plant supplied by the Brush Electrical Engineering Company, the Dover Company's directors in their report state:—"In October last, exhaustive tests were made by Profs. A. B. W. Kennedy and Silvanus Thompson of the whole of the machinery in the station, with gratifying results, the efficiency of the plant being found to be very satisfactory." The professors, in concluding a lengthy report, state:—"On the whole matter of the working of the boilers, and of the running of the plant in the station, it gives us pleasure to say generally, in conclusion, that as to output, efficiency, and economy, as well as in respect to general construction, the results are very satisfactory, and are substantially in accordance with the conditions of the specification." The contract for street lighting has been increased, and the equivalent of 4,557 8-C.P. lamps has already been connected to the company's mains.

The Richmond (Surrey) Electric Light and Power Company, Limited.—The Richmond station, in which this company obtained the controlling interest in April, 1895, has yielded, with an equivalent of 5,486 8-C.P. lamps connected at December 31st last (being an increase of 1,746 8-C.P. lights within the year), a profit of £230 2s. 1d. upon the 12 months' running, as against a loss of £978 19s. 8d. in the previous year. Additional mains have lately been laid in order to reach new consumers, and further extensions are now under consideration.

Mr. A. N. Denny, owing to unavoidable absence from England, has resigned his seat at the board, and the directors have elected Mr. Emile Garcke to fill the vacancy thus created. The retiring directors are Mr. J. B. Braithwaite, jun., and Mr. A. H. Sanderson, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

The Metropolitan Electric Supply Company, Limited.

Sir Eyre M. Shaw presided at the ordinary general meeting of this company held at Winchester House on Tuesday last. After speaking of the illness of the chairman (Sir John Pender), he went on to consider the accounts in detail. The expenditure had been practically confined to five items:—Buildings £5,467, machinery £5,016, mains £18,026, transformers and connections £12,884, and meters £3,038. The expenditure on buildings had arisen mainly in connection with the extensions at Sardinia Street. Expenditure on machinery was due to the provision that was being made for a considerable increase in their power of supply. Mains had to be continually growing to meet the increased demand, and the item under this head therefore needed little explanation. This expenditure had been met by drawing on the debenture stock issued in 1894, of which a further sum of £31,640 had been issued, making a total of £181,640 out of the authorised sum of £250,000. They had issued it at a considerable premium, which premium for 1895 had been placed to capital account. The revenue from consumers had increased by £21,101, against the increase of £16,151 in 1894. Total cost of manufacture was £52,536, or 49½ per cent. of the income, against £42,365, or 50 per cent. in 1894. The chairman then went on to refer to the effects of the fire at Sardinia Street Station, which had resulted in an increased charge for maintenance on boilers, engines, &c. The result of the revenue account was that they had made a profit of £39,154, which, after additions and deductions, became a net amount of £34,082. Taking the depreciation at the sum written off in 1894, this would have given a 5 per cent. dividend, but the board, after careful consideration, were of opinion that in view of the future of the company, a strong reserve for depreciation was of the utmost importance, and he thought that the dividend of 4 per cent. which was recommended would be satisfactory to the shareholders, especially as a very small increase in the current year would place them on a strong 5 per cent. basis. The fire at Sardinia Street was the misfortune of the year. That its effects were no worse was due to the fact that it happened in a period of the year when the load was lightest; to the trunk mains which connected their various stations, and to the assistance promptly rendered by the London and City of London companies. The most careful preparations had been made to prevent the recurrence of such a catastrophe. As the new works had not been fully completed at the end of the year, a suspense account appeared in the general balance-sheet. The steps they had taken to remove vibration in the stations had been successful. The competition with which they had been threatened in the Strand had become a fact, as the provisional order obtained by the Charing Cross and Strand Electricity Supply Company had been confirmed by Parliament. They opposed the confirmation, and were of opinion that the decision was unjust to them and detrimental to the public. The competition came unfairly after they had built up a business in that district. They could observe no falling off in new customers, but the increasing demand implied an increase in the capital outlay. To encourage a larger use of current, particularly during the lighter hours of the day, they had decided to reduce the rates to those consumers whose consumption assisted their output, thereby reducing their working costs. With regard to extensions, Mr. Frank Bailey, some time ago, laid before them his estimates of the requirements up to the year 1900. In addition, the estimates provided for important rearrangements of the system of supply, which would result in considerable saving in the cost of distribution. He alluded to the formation of transformer sub-stations, which the lighting density in some of the districts would shortly warrant, and the result of the increased expenditure would no doubt tend to a steady increase of earnings. They had come to no decision as to what form the new capital would take, but the shareholders would be called together, to consider the scheme when determined upon.

The adoption of the report was then seconded by Admiral of the Fleet, Lord John Hay.

Mr. Harrison Cripps, a shareholder, complained of the small dividend, and spoke of the large working expenses compared with the City Company, the Westminster, and the St. James's Company. He also pointed out the very large sums spent in coal compared with other companies.

Mr. Geipel spoke of the large coal bills being due to the system of transforming.

The Chairman, in reply, said that the coal consumption had been undoubtedly high, but he would point out that they had a class of machines which cost very little, but the coal consumption of which was heavy, while other companies had paid more for their machines, and the coal consumption was less. The difference, however, in the districts accounted for a great deal of the difference in the coal consumption.

The reports and accounts were then adopted.

The Direct United States Cable Company, Limited.—

The board has resolved upon the payment of an interim dividend of 2s. 6d. per share, free of income-tax, being at the rate of 2½ per cent. per annum for the quarter ending March 31st, 1896, such dividend to be payable on and after the 24th prox.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 29th, 1896, were £918; week ending March 31st, 1895, £962; decrease, £14; total receipts for half-year, 1896, £12,656; corresponding period, 1895, £12,648; increase, £8.

The Liverpool Overhead Railway Company. The receipts for the week ending March 29th, 1896, amounted to £1,133; corresponding week last year, £1,002 increase, £131.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 27th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,338.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation March 25th.	Closing Quotation, March 31st.	Business done during week ended March 31st, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10½— 11	10½— 11	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	47 — 49	47 — 49	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	89 — 90	90 — 91	90⅝	89½
2,993,560£	Do. do. Defd.	Stock	...	...	...	7⅜— 8¼	8 — 8½	8 5/16	7⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	7 %	...	14½ - 14⅝	14½ — 14⅝	14⅝	14⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3 — 3⅛	3 — 3⅛	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	...	3/16— 5/16	3/16— 5/16	1/16	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13½	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½— 21½	20½— 21½	21½	20½
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	9½— 9⅝	9½— 9⅝	9⅝	9½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼% §	6¼%	...	17 — 17½	17 — 17½	17 7/16	17 3/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18 — 18½	18 — 18½	18 5/16	18½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	129 —132	129 —132	132	131
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17⅜— 18¼	17⅜— 18¼	18⅛	17⅝
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	128 —131	128 —131	128½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115%	112 —115 %	112½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4⅛%	...	10½— 10⅝	10½ - 10⅝	10 1/16	10½
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16⅜— 17½	16⅜— 17½	17⅛	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	...	22⅜— 23½	22⅜— 23½	23½	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	47 — 50	48 — 51	50½	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	107 —110	107 —110	107½	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5¼%	6⅜— 7	6⅜ - 7	6 15/16	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½ — 17½	16½ — 17½	16 13/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 6⅝	6⅜— 6⅝	6⅜	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	106 —109	107⅜	107½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	...	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 — 111	108 —111	109	..
11,839	Reuter's Ltd.	8	0 %	*nil*	...	5 — 6	5 — 6	5 1/16	..
3,381	Submarine Cables Trust	Cert	...	...	...	132 —137	134 —139	136	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½ — 4	3½— 4	...	...
146,732£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	97 —102	96 - 101	98½	98
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	..
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	..	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	1	..
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	95 —100	95 — 100	95¼	...
54,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	8½— 9	8½— 9	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 6⅝	6½— 6⅝	6½	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	2¼— 2⅜	2¼— 2⅜	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅛%	...	1 — 1⅛	1 — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10⅜— 11¼	10⅜— 11¼	11⅜	11
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Stor. Bonds ...	100	6 %	6 %	...	102 —105	102 —106 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	7½— 7⅝	7½— 7⅝	7 11/16	7½
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7½— 8	7½— 8	7⅞	7 13/16
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 —119	116 —119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½ - 15½	14½— 15½	15½	14⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	16⅝	16⅜
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10½— 11½	12½— 13½	13	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅜ — 7⅞xd	7⅜— 7⅞xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	12½ - 12⅝	13 — 13½	13½	12⅝
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	8⅜— 9½	8⅜— 9½	9 1/16	8⅞
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	9¾ - 10½	9¾— 10½	10	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ — 10	9⅝— 10½	10	9⅝
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½— 10	9½— 10	9 15/16	9¾

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Mar. 25th.	Closing Quotation, March 31st.	Business done during week ended Mar. 31st, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	1½ — 1⅝	1½ — 1⅝	1 3/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1⅝ — 1¾	1⅝ — 1¾	1¾	1⅝
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
530,000£	City and South London Railway	Stock	1⅛%	1½%	1 3/16%	40 — 42	40 — 42	41¼	40⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2¼ — 2⅜	2¼ — 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1¼ — 1⅜	1¼ — 1⅜	1⅜	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4	3 — 4 xd	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	103 —106	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2¼ — 2⅜	2¼ — 2⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	5/16 — 7/16	5/16 — 7/16	...	...
69,385	Elmore's Wire Mtg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	5/16 — 7/16	5/16 — 7/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	¼ — ⅜	¼ — ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½ — 10½	9½ — 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16½ — 17½	16½ — 17½	17½	16¾
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17 — 18	16½ — 17½	...	...
5),000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	107 —112	107 —112	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20 — 21	20 — 21	20½	...
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2%	14 — 14¼	13¾ — 14¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅜ — 16⅝	16⅜ — 16⅝		...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	39¼	38⅛
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	6 — 6½	6¼ — 6⅜	6⅜	6¼

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—5%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 6—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 3¼—3½.

Do. do. 7 % Preference, of £5, 8—8½

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8¼—8⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅞—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

THE REGULATION OF PRESSURE AND THE REDUCTION OF LIGHT LOAD LOSSES IN ALTERNATING CURRENT SYSTEMS OF ELECTRIC SUPPLY.*

By E. W. COWAN, Member of Council, and ALFRED STILL, Member.

(*Concluded from page* 411.)

Fig. 6, diagram No. 3, and diagram No. 4, illustrates the regulating transformer manufactured by the Manchester Edison Swan Company, Limited, as first made for the Bolton Corporation. In this design the primary coil is wound upon a shuttle-shaped core and the secondary winding upon a ring-shaped core. Between the positions of maximum effect and no effect the primary coil, with its core, rotates through an angle of 90°. The action is as follows:—

In the position of maximum effect the shuttle occupies a vertical position, and the magnetic flux cuts the secondary coil, which is wound in two sections, one on each side of the ring, and generates the full volts required. In the position of no effect the shuttle is horizontal, and the magnetism cuts half the secondary turns in a positive sense and half in a negative sense, the resultant effect being, of course, *nil*. Between these two positions any gradation of augmentation can be obtained. It is evident that if the shuttle be rotated beyond the position of no effect (if the transformer is being used as a feeder regulator), volts will be subtracted from, instead of added to the feeder volts. The points to which special attention were paid in the design of this apparatus were the constancy of magnetic flux in all positions, the reduction of the iron path to the shortest possible length to avoid iron loss; and the obtaining of a mechanical and compact apparatus which would lend itself to easy and safe manipulation by the switchboard attendant.

On the table we have one of the Manchester Edison-Swan regulators at work. The Manchester supply being a continuous current—a motor alternator first converts it into an alternating current of about 20 complete periods per second. The alternating current supplies an incandescent lamp, and the regulator is so connected that the pressure at the lamp terminals can be raised or lowered by hand adjustment of the lever on the side of the case.

* Paper read before the Northern Society of Electrical Engineers, March 23rd, 1896.

Compensators.—With regard to the means of indicating the feeding point volts at the station end, there are several methods by which this can be done. Pilot wires brought back from the feeding points to the voltmeters naturally suggest themselves in the first place, but there are objections to their use, of which the principal one, perhaps, is their excessive cost, especially when they are used in connection with long feeders.

A very simple method of indicating what is the required pressure at the station end of the feeders in order that the supply at the far end may be independent of variation in load, consists in marking on the feeder ammeters a second scale of numbers—let us say in red figures:—these numbers to indicate the required value of the station volts for any position of the ammeter needle.

A step in advance of this, is a method which is more generally used in America than in this country. It consists in connecting the voltmeter in series with the secondaries of two transformers; a shunt transformer, T (fig. A, diagram No. 5), with its primary across the mains, and a series transformer T 2, of which the primary is traversed by the main current. The secondary of this transformer being closed through an adjustable resistance R, it will be readily seen that by suitably varying this resistance to suit the length and size of the feeder, the potential difference between the terminals, *t*, *t*, may be adjusted to any particular fraction of the volts lost in the feeder. It follows that by setting this potential difference against the potential difference at the secondary terminals of the shunt transformer, the readings on the voltmeter will be an indication of the actual pressure at the feeding point.

In fig. B, on the same diagram, is shown the way in which this method of "compounding" the feeder voltmeter is illustrated in Dr. J. A. Fleming's book on transformers. In the text we read that "The electromotive forces of the two transformers are opposed to one another"; but this will not be the case unless the secondary of the series transformer is closed through a resistance, as in fig. A. The secondary volts of the shunt transformer being in opposite phase to the primary volts, and the induced volts in the series transformer being approximately ¼ period behind the main current, these two E.M.F.'s cannot be set *against* one another, and their sum must necessarily be *greater* than the value of any one of them.

Drop in Distributors, &c.—We have so far dealt only with the loss of pressure in the feeders and methods of keeping the volts constant at the feeding points. Beyond this the system must be self-regulating, that is to say, the loss in pressure between no load and full load must not exceed a certain definite amount.

The amount of permissible variation at the consumer's terminals, as fixed by the Board of Trade, is 4 per cent. If, therefore, we proportion the distributers to give a maximum drop not exceeding 2 per

cent., this leaves another 2 per cent. for permissible drop in transformers.

And here it may be as well to point out the disadvantage of specifying for transformers having a very small drop between no load and full load, without considering the effect of the drop upon the first cost and efficiency at light loads. It should always be borne in mind that for the same cost of material a transformer may be made to give either a small drop with a comparatively large iron loss, or a fairly considerable drop with greatly reduced open circuit losses.

As an illustration in actual practice which bears out this statement, a few months ago we tested a transformer for which the makers claimed an unusually small loss at light loads. The tests proved that the claim was undoubtedly well justified, but at what cost? The drop on volts on secondary terminals between no load and full load was no less than 5 per cent. On the other hand, a transformer of the same output by another maker had an open circuit loss nearly one and a-half times as great; and this, although the weight of the transformer, and therefore the amount of material in it was greater than the first one; but this greater iron loss was necessary in order to bring the drop within reasonable limits, the maximum variation being just within 2 per cent.

In very small transformers it is difficult to keep the drop much below 2½ per cent.; a better regulation than this is rarely found in practice, notwithstanding specifications, and maker's published figures.

With regard to the drop of pressure in the house wiring, we believe there is very little that is new to be said on the subject. It should, however, be borne in mind, in calculating sizes of wires, that their effective resistance to alternating currents is always a little greater than when they are traversed by a continuous current. Mr. E. Hospitalier has worked out a very convenient table, from which the increased resistance of wires to alternating currents for various diameters and frequencies may be easily obtained. It is, perhaps, needless to remark that this increased resistance is practically negligible except for wires, say, over ½ inch in diameter, and comparatively high frequencies.

Transformer.

Before leaving this first section of the paper, it should, perhaps, be mentioned that a small regulating transformer connected in series with the low tension wires entering the houses may be used for keeping the pressure constant within a fraction of a volt, notwithstanding variations in the supply at the consumer's terminals.

One of these house regulators is on the table.

Reduction of Light Load Losses.

There are few subjects of greater interest to the electrical engineer in charge of an electricity supply station than the question of light load economy.

The maintenance of a continuous supply cannot be avoided, but the cost of generation during the hours of light load is enormous. The waste, and no other word adequately expresses the loss which takes place, is not only in fuel, but in wages and capital.

There is no occasion to define the lightness of the load during the small hours of the morning and the long hours of daylight; in the majority of electric light stations in this country, the feeder ammeter needles rest persistently at zero. It is to such stations that our remarks will apply.

An examination of the question shows us that there are perhaps four ways of meeting the difficulty:—

1. Installing accumulators, which are charged during the hours of heavy load, and employed during the hours of light load in driving a motor alternator of a similar kind to the one on the table, but, of course, multipolar.

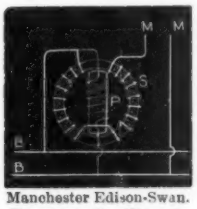
2. By running a small, and therefore more economical light load plant.

3. By a gas engine and gas generator plant.

4. By adapting one of the smaller units in the station to work at a relatively high economy when lightly loaded.

Below we deal briefly with these four methods.

Installing Accumulators.—Mr. J. C. Howell, supported by Mr. Crompton, endeavoured some time ago to persuade the members of this Society that accumulators offered a means of saving many tons of coal per diem, even if they were only used as resistances for shunting the balance of current required to raise to full load the output of a steam dynamo. This startling assertion was accepted in many quarters, but we are unable to allow that accumulators can possess such a virtue. The question of their adaptability to alternate current stations, in conjunction with a motor alternator to effect economy, becomes a difficult one to decide. The Bolton Corporation are putting this plan to a practical test, and we shall look forward to hearing at a later date some account of their experiment. It is a question of interest on capital outlay, depreciation and maintenance on the one hand, against saving in fuel and wages, and also the undoubted advantage of being able at times to shut down the steam plant entirely, on the other.



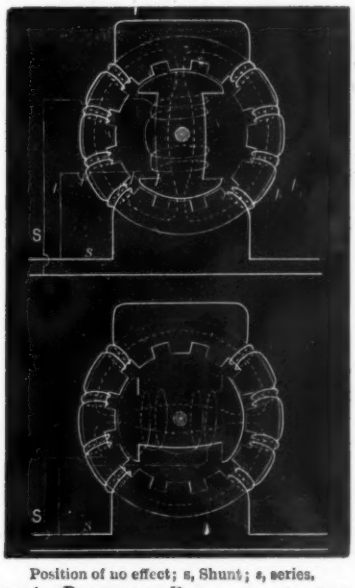
Manchester Edison-Swan.

Diagram 3.—Fig. 6.

Separate Light Load Plant.—This is the plan which has found most favour up to the present time. One objection is its first cost, and another the frequent necessity for changing over from one plant to another, which, as it involves paralleling, needs the presence of a skilled attendant. This is felt most in the early morning in winter time, when the load is relatively heavy for an hour or two, and a small plant cannot meet the demand.

Gas Engine and Gas Generating Plant.—At first sight a gas engine appears particularly fitted for this purpose, as it is theoretically an engine with a high efficiency at light load, on account of the gas consumed being proportional to the indicated horse-power. But there is another factor which influences the gas consumption, viz, the friction of the engine. In order to adapt a gas engine to driving an alternator, it must have two or more cylinders and a heavy fly-wheel,

Position of maximum effect.



Position of no effect; s, Shunt; s, series.

Diagram 4.—Diagram of Regulating Transformer.

the consequence being that the standing friction losses are largely increased, thus seriously affecting the economy at light loads. The first cost of such a plant is, of course, much higher than that of a steam engine of similar power.

Adapting one of the Smaller Units in the Station to Work at Relatively High Economy when Lightly Loaded.

We are fully aware that in recommending this plan as being the most effective and economical, we are laying ourselves open to considerable criticism, especially as some of the suggestions we shall make are in the direction of rather bold departures from present practice. But it must be remembered that in dealing with the difficulties of a low "load factor," we must expect to be obliged to surrender some of our prejudices. The difficulties are peculiar, and may have to be met in a peculiar manner.

It is impossible to deal with this subject without saying something about the many arrangements which tend towards economy at light load in the generation and transmission of steam.

Time will not admit of the discussion of the different types of boilers. It is, of course, unwise to instal a small boiler for light load, and we do not suppose that anyone would think of doing so, but it does not seem to be generally so well known that a Lancashire boiler, at any rate, works at a much higher economy at quarter load than at full load if it is well lagged and carefully stoked. A boiler cannot have too much heating surface, though it can have too much grate area. With careful stoking, a consumption of 5 lbs. of fuel per square foot of grate area per hour in a Lancashire boiler will give a splendid evaporative performance of over 12 lbs. of steam from and at 212° F. per pound of coal, or 10 per cent. better than with a normal consumption of 20 lbs. of coal per square foot of grate per hour.

Economiser.—It might be thought that an economiser would not effect much saving at light loads, on account of the lower temperature of gases; but we have obtained an augmentation of temperature of the feed of 138° F. with a 96 tube Green economiser, when working a Lancashire boiler 30 feet × 7 feet at quarter load, and burning 5 lbs. of fuel per square foot of grate per hour. Prof. Kennedy has obtained an evaporation of 12·4 lbs. of water per pound of fuel with economiser, and 11·7 without, when burning only 6 lbs. of fuel per square foot of grate per hour.

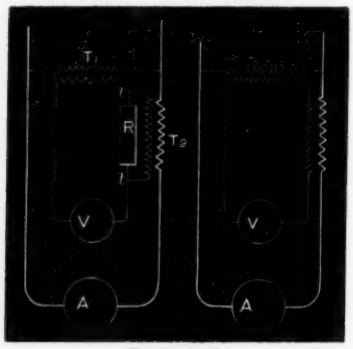
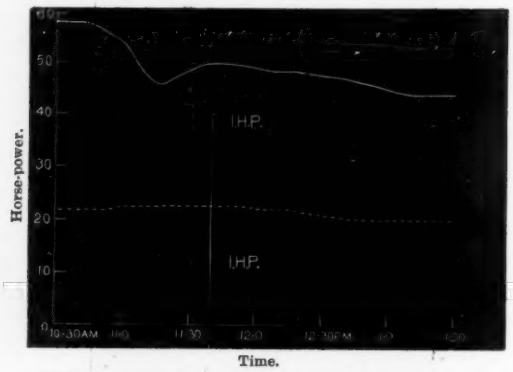


Diagram 5.

Boiler Feed.—The wastefulness of steam feed pumps is well known, and in many stations electrically driven pumps are now being fitted. Where the feed water is heated above 150° F. a feed pump of some sort becomes necessary; but in other cases injectors offer a means of feeding the boiler which is simple, inexpensive, and we venture to say, economical.

The three objections generally made against the use of injectors are—unreliability, small range of regulation, and lastly, that they are uneconomical.

As to the first objection of unreliability, this is not borne out in practice so far as our experience goes, but a steam pump as a stand-by should undoubtedly be erected.



I.H.P. above atmospheric line; I.H.P. below atmospheric line.

Diagram 6.

The second objection of the small range is easily got over by fixing three or four different sized injectors delivering in parallel into a common or "omnibus" delivery pipe. They work perfectly well in parallel, and in this way any required rate of feed can be obtained.

The third objection of their being uneconomical is not, we think, a true one. Both in theory and in practice, as far as we have been able to ascertain, they are more economical than steam pumps. As a pump pure and simple the injector is of course very inefficient, but energy cannot be extinguished, and it therefore follows that all the units of heat in the steam supplied to the injector are returned to the boiler, with the exception of the equivalent of the work done (the product of the volume of water injected and the back pressure) and a small loss due to radiation. It must of course be remembered that though all the heat is returned to the boiler, it is returned at a lower temperature—in fact, the live steam is used to heat the feed water from, say, 60° F. to 150° F. and this process violates one of the first conditions of economy. But compare it with an ordinary steam pump; about 50 per cent. of the total heat in the steam supplied to the pump is rejected in the exhaust, to which must be added large losses due to radiation and the more obscure losses due to reciprocation. It is difficult to compare the relative efficiencies of the one method which raises the temperature of the water from 60° F. to 150° F. by live steam, and from 150° to 320° in the boiler; and the method in which the temperature of the feed water is raised from 60° to 320° in the boiler; but common sense seems to point to there not being much difference between the two. The use of economiser or feed water heater will of course somewhat alter matters, and each case should be considered on its own merits. Our firm conclusion is that an injector is the best light load pump.

Steam Pipes.—There are grave objections to supplying the light load plant with steam from the main steam pipe. This plant should be erected as close as possible to the boilers, and supplied by a short anxiliary pipe of small diameter. It has been estimated that the radiated heat from every square foot of lagged steam pipe costs 300 lbs. of coal per annum, and Professor Kennedy has found that the amount of condensed steam from pipes, drains, &c., amounted in one station to from 8 to 9 per cent., and in another from 5 to 6 per cent. of the total weight of feed water.

Auxiliaries.—The economiser scrapers, centrifugal pump and exciting dynamo must be driven during the hours of light load; and it is evident that if these are driven separately by auxiliary engines the result will be a serious waste of steam. We prefer to arrange for their being driven by the main day load engine, using either belt, rope, or electrical transmission. As this engine is running in any case, its standing losses are not chargeable against the small extra power required, which can therefore be obtained at the very small expenditure of steam of about 12 lbs. per H.P.

Condensers.—We unhesitatingly recommend the ejector condenser as being the most economical light load type. No air pump is needed, and thereby a substantial standing loss avoided. It is an absolutely reliable, cheap, and efficient piece of apparatus. The type with a means of regulating the adjustment of the nozzles is, perhaps, best suited to a variable load. The subject of the saving effected at light load by the removal of the standing loss of atmospheric back pressure by condensing the exhaust steam has been so ably and fully dealt with by Mr. Willans, that we do not propose to add any remarks of our own, excepting to say that it is by far the most important of the means we are bringing before you for the reduction of light load losses. We show on diagram No. 6 the saving of steam effected during the day time at Altrincham by the use of an ejector condenser. The diagram shows the I.H.P. below and the I.H.P. above the atmospheric line on the morning of December 20th, 1895. The I.H.P. below the atmospheric line amounted to about 46 per cent. of the whole, or a saving of steam consumption of about 50 per cent., against which must be set the H.P. required for centrifugal pump, about 1 per cent. of the total H.P. of the engine.

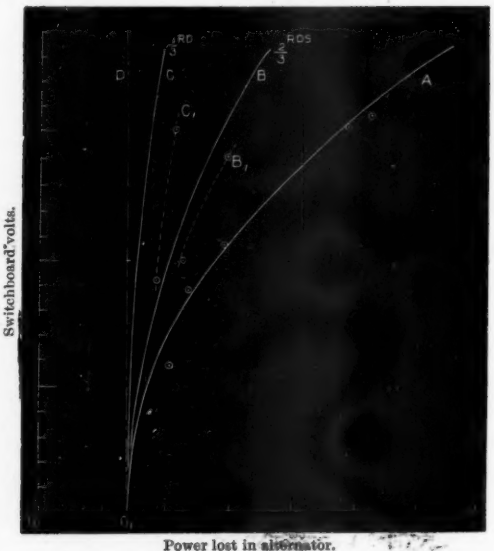


Diagram 7.

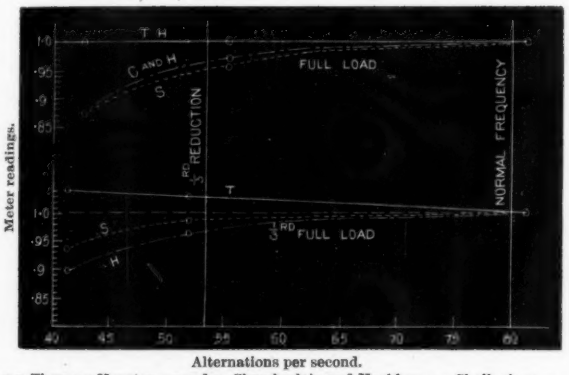
Engine.—The discussion of the engine brings us back to our recommendation that one of the smaller units should be adapted to run economically at light load. A steam engine runs very wastefully under these conditions, partly on account of its standing losses being practically constant at all loads, and therefore bearing a larger proportion to the power developed at light load than at full load, and partly on account of the steam distribution between the H.P. and L.P. cylinder being unequal at light loads. The latter point should be dealt with by designing the engine with an automatic cut-off governor, which acts on both the H.P. and the L.P. valves. In this way a fairly equal range of temperature in the two cylinders can be maintained at all loads. The cylinders should also be steam jacketed on account of the range of expansion being relatively great at light loads. Of the standing losses, the back pressure of the exhaust has already been dealt with, and the loss due to radiation can only be met by careful lagging of the cylinders and their covers. Lastly, there are the important losses due to engine friction and vibration. The only way of reducing these is by lowering the engine speed. These losses are so much per revolution, and if we lower the speed we reduce them in like proportion. We recommend that the speed should be reduced by about one-third, and that the governor should

be so designed as to allow of an adjustment of its springs being made by hand, in order that the engine may be under its control at this reduced speed. As far as the engine is concerned, there can be no doubt of the advantage of this plan; its effect on the electrical plant we deal with below.

Alternator.—The type of alternator which gives the highest efficiency at light load is undoubtedly the one having no iron core in its armature. But the reliability and mechanical strength of the iron-cored armature has so much to recommend it, that it has found great favour, and we think rightly so, with central station engineers. Probably the protection which the self-induction of the machine affords to the whole system, in absolutely limiting the maximum current which it is possible to obtain from such an alternator, to only a harmless amount above the normal, has also done its part in placing this type in the position which it occupies at the present time. Engineers will readily sacrifice some efficiency and self-regulation to obtain such a "factor of safety" as the iron-cored alternator possesses.

It must be remembered, however, that the eddy current losses in an iron-cored armature are less at full load than on open circuit, a fact which was first, we believe, observed by Dr. John Hopkinson. We have recently made some experiments in connection with another matter in which this effect was very clearly marked.

Apart from the windage and bearing friction, the hysteresis and eddy current losses in an iron cored armature, when lightly loaded, may be considerable. On account of the peculiar raking of the magnetic lines, the iron losses in an armature for any particular values of the induction and frequency, are greater than they would be if the same volume of iron were simply submitted to reversals of magnetism, as in a transformer. The core losses in an alternator will increase approximately as the square of the induction; if, therefore, we could reduce the induction in the armature, a great saving of the all day losses would be effected. For instance, suppose the armature to consist (as it often does) of two separate windings connected in parallel; by switching these in series during the hours of light load, the induction in the core would be halved, and the iron losses consequently reduced to one-fourth of their former value; the losses in the exciting circuit being also reduced in the same proportion. Such an arrangement could not be worked without causing fluctuations in the light; but a little consideration will show that the same saving may be effected by the use of a step-up transformer. The alternator is excited to give, say, half its normal voltage, and its armature is connected in series with a transformer, wound to add the remaining half of the required volts. The loss in such a transformer will be very small compared with the saving in the alternator. All that now remains to be done is to make this transformer a regulating one, which will enable the volts added to be varied without any sudden fluctuations. The change of the alternator from a small output machine to one capable of dealing with the full load it was designed for, can also be made without any variation in the light, by simultaneously reducing the volts added by the step-up transformer, and increasing the excitation of the alternator, as well as bringing up its speed, if this has been reduced as recommended when dealing with the question of engine efficiency.



Alternations per second.

T H, Thomson-Houston; C and H, Chamberlain and Hookham; S, Shallenberger.

Diagram 8.

The capital outlay on such an apparatus would not in any case amount to much; but where regulating transformers are used for equalising the pressure at the various feeding points, as recommended in the first part of the paper, they can be, without any difficulty, adapted to do duty both as regulators of pressure and step-up transformers. The secondary must be wound with several separate windings which, by means of a special switch, can be connected either in series or in parallel. By means of a simple interlocking device this switch may be so arranged that it can only be thrown over at a time when the transformer is in the position of no effect.

In diagram No. 7 are plotted the results of some experiments which we have made on an iron-cored alternator in order to prove what has just been said with regard to the saving of alternator losses. The alternator was driven at constant speed on open circuit by means of a small continuous current motor, and readings were taken of the power supplied to the motor for various inductions in the armature. In the diagram the vertical distances are proportional to the volts as read on an electrostatic voltmeter, and the horizontal distances are proportional to the power supplied to the motor, a correction being applied for the losses in the motor itself.

The distance, O, O, represents the losses in windage and bearing friction; it is the power required to drive the alternator with the field magnets unexcited. The curve, O_1 A, is a parabola, the distance of any point on the curve from the vertical line O_1 D, being proportional to the square of its height above the horizontal datum line. The points enclosed by the small circles are the results of the experiments, and by their agreement with the curve O_1 A, serve to show that, in assuming the iron losses in the armature to be proportional to the square of the induction, the error—if any—is very small.

The curves, O_1 B, and O_1 C, are also parabolas; but for equal ordinates the horizontal distances from the line, O_1 D, are respectively four-ninths and one-ninth of their value for corresponding points on the curve, O_1 A. These are the curves which would be obtained by connecting the secondaries of the step-up transformers in series with the armature circuit, on the assumption that the losses in the transformers themselves are negligible. In the case of curve B, the alternator generates two-thirds of the full volts, and the step-up transformer supplies the remaining one-third. Two experimental readings were taken through which the curve B has been drawn. These readings, of course, include the losses in the transformer. The dotted curve, C, was obtained when the alternator generated only one-third of the total volts. In this case, as will be seen by inspection of the diagram, the step-up transformer absorbed rather more power than in the previous experiment.

Indicator diagrams of the horse-power of the engine showed the same saving.

In conclusion, we must deal with the effects of the alteration of frequency which result from the reduction of speed by one-third. In the first place, the hysteresis losses in the transformers are increased by about 25 per cent., while the eddy current losses remain approximately the same. As the C^2 R losses are small when the load is light, the resulting temperature will not be abnormally high. The question, therefore, naturally arises as to whether the saving in the engine is not made up for by the increased losses in the transformers? The best answer to this question is to give you the result of a careful experiment made at Altrincham. In this experiment the speed of the engine was reduced from 350 to 246, and the saving in the 1 H.P. was 16·1 per cent., which is equivalent to a saving of 17 per cent. with a reduction of speed to two-thirds full speed. It must also be remembered that at Altrincham the transformers are for the most part fixed on consumer's premises, and are, therefore, of small size. Under ordinary circumstances, with large transformers the saving should be at least 20 per cent.

The effect of the alteration of frequency upon the meters is not serious. If Thomson meters are used, the error for a third reduction is practically negligible. With Shallenberger and Hookham meters it amounts to from 1½ to 5 per cent. We have made experiments on these meters, the results of which are plotted on diagram No. 8. In this diagram the horizontal distances represent the frequency, and the ordinates show the variations in the readings of the meters. Vertical lines are drawn at the points of normal frequency and at a third reduction. Curves are drawn for both full load and a third full load.

As to the effect of the reduction of frequency upon arc lamps and alternate current motors, there is little to be said. Our experience is that the effect upon the ordinary commercial arc lamp is not appreciable, and it will be time to consider its effect upon motors when they come into practical use.

We have endeavoured in this paper not only to make recommendations, but to support them as far as possible with figures ascertained from actual practice or experiment.

We hope that some of the members present who have charge of central stations will be able to give us the result of their experience both with the difficulties of regulation of pressure and light load economy.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on High-voltage Lamps for Central Stations, March 12th, 1896.

(*Concluded from page* 427.)

Mr. Epstein* said the figures contained in the paper were borne out by his experience, and he really had no fault to find with them. He agreed with what Mr. Addenbrooke said about the cheapening of accumulators, inasmuch as they all anticipated that the last word in regard to the cheapening of accumulators, or as to the way in which accumulators could be used to the best advantage had not yet been spoken, and he thought they might anticipate further advantage from that source.

Mr. A. A. C. Swinton* said Mr. Geipel had touched on the question of efficiency, which, of course, was a very important one, but he thought it ought to be carried a step further. They were told that the efficiency was so many watts per candle. Now what did a candle mean? There were two candles; there was a foreign candle, a German candle, he believed, and an English candle, and he must say that in many cases he had been much puzzled to know to what particular candle-power the makers referred. He was not referring to the difficulties of measurement, although there were great difficulties in the measurement of the candle-power of lamps, but he referred to the standard. There were two standards, and he thought it was very desirable that they should have only one, so that they would know what they were talking about.

Mr. W. H. Patchell* said he had not had time to read this paper, although it had been sent out a week before, but on looking over it, it had struck him as a paper of extreme moment. There were several things in it which touched central station practice very pertinently. He had tried for some time to introduce 200-volt lamps, but he had first tried to get the lamps at the same price as those at 100-volt.

* Speakers marked with an asterisk have corrected their remarks.

This was of manifest importance to every central station engineer, for if he doubled his pressure the capital value of his mains was increased, but when the consumer came to pay the bill for lamp renewals, he thought the company would have to subsidise the consumer to some extent, or find him the lamps at a loss. Whether that would pay the company was a moot question. He thought as they had so many lamp makers present, they ought to impress upon them the importance of having the price the same as for single pressure lamps. They had heard that night of difficulties with 100-volt 8-C.P. lamps, but he had had no trouble with them when run at a steady pressure. Those who had had difficulties could not have run them on a steady pressure.

Mr. H. W. Handcock* said a client of his firm had for a long time been complaining about his lamps going, and the matter was a mystery to them. At last they told him the best thing to do was to see the engineer at the central station. The result was he was advised to use 110-volt lamps instead of 105-volt. This was a little bit suggestive, as the circuit was only 105 volts. They could all draw their own moral from this. He was a little surprised, and also interested, to hear from Mr. Stearn that he found the twisted filament lamps better than the straight filament lamps for horizontal positions. Possibly he had not understood him rightly, but he had always been under the impression that the straight filaments were the better, owing to the extra weight of the twist at the end of the other filament. They had heard a great deal about the satisfactory life of 200-volt lamps, and the advantages of these lamps had been demonstrated to them very obviously, from the central station point of view; but they had not heard very much from the consumer's side. Possibly they should first have before them relative figures. That was to say, taking a lamp of the same efficiency, the same life if they liked, they wanted to know what was its efficiency at 200 volts, what was the efficiency of a similar C.P. lamp at 100 volts, and also what was its efficiency at 50 volts; also what was the C.P. of that lamp at each voltage at the end of 1,000 hours. In their experience they felt that with the 100 volts the limit had been about reached. Occasionally they had very good lamps, but when they went far above that they had so much trouble, and such continuous complaints about filaments going, that it was evident the life was very uncertain. If the voltage were steady it was quite a different thing; and he thought the inventor of the incandescent lamp had struck the right nail on the head when he spoke of the great fluctuation of pressure they were subject to at the present moment. When in America, he was very much impressed with their photometric arrangements there. As things were, 90 per cent. of the difficulties were due to faulty lamps, and the trouble was got over in New York by the company including in their rate the lamps themselves. Every lamp went through their laboratory, and was carefully tested with the photometer; anything not coming up to their standard was rejected and returned. If they had some similar system here, the gain would be very considerable. Going back to the question of efficiency, he should like to ask now they had so many lamp makers present, and he should also ask central station engineers, this question: If they doubled their voltage, were they going to supply the consumer with current at such a rate that if he got the same amount of light out of his lamps, his account would be the same, instead of 33 or 34 per cent. more than it was now? Taking the case of 3 watts on the existing circuits, where an account amounted to £100, with 4 watts that account would come out at £130. Were they to expect a substantial reduction? In 220-volt installations, his firm certainly found a continuous source of trouble in the fittings now on the market; 25-ampere switches would not switch off, cut-outs arced across and blew right out, and, altogether, they had a very unfortunate experience. It was not the case that they got cheap fittings; they used the best fittings procurable, and they had far more trouble on the 200-volt circuit than on the 100.

Mr. W. R. Rawlings* said if they were going to compete against gas, it was necessary to carefully consider the question of cost. He was very often called in by people who wanted to know the reason of their enormous electric accounts, and he very often found that in out of the way places, such as water-closets and coal-holes, 16 C.P. lamps were kept burning simply because those lamps had a long life. If they reduced those lamps to 3 C.P., such as some of the 100-volt lampmakers were giving them, and put in 8 C.P. lamps where more light was required, they would then reduce the electric account to something reasonable. There were many places where a small light was required, such as dark passages in basements. A short time back a question arose as to whether it would be more economical in the case of such a passage to cut in daylight, or to burn a small incandescent lamp continuously, and for a 3 C.P. or a 5 C.P. lamp it worked out cheaper in that way; but had it been necessary to burn a 16 C.P. lamp, the electric light would not have been used. If the lampmakers could give them a good 200-volt lamp at 3 C.P., or less, that would overcome the difficulty; but, if they must look on the 8 C.P. lamp as a minimum, they would still be troubled with this heavy electric account.

Mr. Sydney W. Baynes*: I regret I am unable to join personally in the discussion, in consequence of a special meeting of the St. Pancras Electricity Committee having been convened for this evening. Under these circumstances, Mr. Snell has kindly undertaken to read my remarks on the paper now under consideration. As I believe I have had the privilege of being the first to employ lamps of high voltage in electrical distribution, a short summary of my experience may not be without interest. It will be necessary to revert, for a few moments, to a period which, so far as electricity supply works are concerned, may now be termed ancient history. In those days it remained an open question whether central stations would ultimately become a source of revenue to municipalities or not; in consequence the expenditure was limited and meagre in comparison to the handsome sums now freely voted by municipal bodies. Shortly after the opening of the Bradford installation in 1889, it became evident that the mains were likely to become loaded in a much shorter time than had been anticipated. It thus became a pressing question with me in what manner I could increase their carrying capacity with the smallest possible capital outlay. After carefully going into the matter, the most promising solution of the difficulty seemed to lie theoretically in the adoption of a three-wire system, with lamps at 230 volts. The three-wire system was already in the market, not so a lamp to suit my purpose. Feeling confident, however, that the lamp was but a question of time, I made ready for its adoption by giving personal attention to every detail in the wiring of premises and prohibiting the use of double-pole cut-outs, so that when the day came for the fulfilment of my expectations, there should be no cause for anxiety in connection with the consumers' premises. I can only touch briefly on the initial difficulties in procuring lamps. After persistent inquiries and interviews, I managed to procure small consignments from several makers. Only one design of lamp, however, survived the tests satisfactorily at that date. After further considerable delay, another firm entered the field and supplied a good lamp; but it became apparent that to achieve any degree of success it would be necessary to encourage the manufacture of such lamps on a commercial scale, and, as I was now satisfied that two makers could be relied on, I resolved to give effect to the scheme which I had so long hoped to put into practical use: accordingly, I issued notices intimating that all future consumers would be supplied at 230 volts. There still remained the terms of the provisional order to consider. The most diplomatic method of dealing with the difficulties therein presented appeared to be, first, to prove the practical utility of the double pressure, and then leave the matter for the consideration of the Board of Trade. I therefore used only the outer conductors as a pair, and thus maintained the spirit of the order. I have to acknowledge my indebtedness to the Board of Trade in allowing me a certain latitude wherein I had time to demonstrate the practicability of the innovation. At an early stage in the working of the scheme I had numerous inquiries from America as to lamps, and the measure of success achieved. I now learn that in the comparatively short time which has elapsed there are over fifteen central stations in the United States working with 200-volt lamps. We are not yet in a position to report such progress on this side of the Atlantic—a striking instance of British caution contrasted with Yankee go-a-headness. Now, in regard to the question of current density, I would suggest that Mr. Addenbrooke is too liberal with his allowance of copper. I prefer to allow for a 2 per cent. variation with distributors extending 880 yards from the feeding centres, and working at a current density of about 700 amperes per square inch. The pressure should be gradually increased to 2 per cent. above the normal at the feeding point as the load approaches maximum, while the pressure on the distributor at the far end would fall 2 per cent. below the normal: thus, by a judicious compromise, we are able to limit the variation at the lamp terminals to 2 per cent. In this way the number of feeding centres would be reduced to a minimum, and might be spaced at intervals of a mile. The generating station would feed direct into the network up to a half mile radius, and the distance in any direction to 2½ miles would be readily dealt with by throwing out two feeders into the district to be supplied. The near-feeder would obviously be worked at double the current density, so that both the near and far feeders would be coupled to one common bus bar. It would be advisable on the score of economy to serve the home portion of the network from a separate bus bar, as the voltage would only be required to exceed the normal by 2 per cent. at maximum load. It being usual to place feeding centres where roads intersect, there would be 8 distributors, each extending 880 yards, or a total frontage of 7,040 yards. Allowing for branch streets, we might readily count on a lamp density of three lamps per yard. This would represent about 3,200 amperes at 440 volts to be delivered to each feeding point. It would be preferable to divide this current amongst four separate conductors constituting the feeder. This method of grouping the conductors simplifies the regulation, and allows for the adjustment of varying pressures by switching off portions of the feeder should any irregularity occur between the feeding centres. The facility in regulating thus afforded would be considerably augmented by a judicious selection of the sectional areas of the cables combining to make up the feeder. Very shortly the King's Road Works will be supplying current with the distributing network extending a total distance of nearly 2½ miles to the furthest lamp. The current density on the feeder will be heavier than that laid down in the paper under review. I may here remark that providing the centre wire network of the distributing system be brought back to the generating station, and reasonable care taken to balance the distribution of lamps, there appears to be no necessity for a centre feeder. In regard to the possibility of using lamps of high efficiency and low voltage; since the regulation at the increased pressure would approach much nearer the ideal than has hitherto been obtainable, these lamps could be adopted two in series, with a success and certainty which is quite impracticable on a system run at 110 volts. The tendency in shop lighting is to group several lamps on a switch, so that it would make little difference whether they were burning in series—parallel or otherwise. If a really reliable high efficiency lamp could be obtained, any waste of current inevitable from the necessity of burning two in series would be a mere trifle compared with the economy effected by their use. Now, as to lamps of high voltage, those makers who have devoted both time and money in perfecting their methods have been remarkably successful in producing lamps of comparatively high efficiency, averaging from 3·3 to 4 watts per candle-power, whilst the average life already greatly exceeds that assumed in the paper. I consider the profession is under an obligation to several of these manufacturers for their persevering efforts to keep pace with the requirements of the electrical industry, and in their courteous endeavours to deal with and remedy any defects that have occurred during the development of the lamp; but for their able assistance and co-operation, we should not be assembled to-night to discuss this

very interesting paper. As to the question of fire risks, where the wiring has been well done, there is undoubtedly less risk than with the lower voltage. 1. Because the fuses are lighter. 2. Should an arc occur across the casing, the current would more readily exceed the carrying capacity of the fuse. In the St. Pancras installation we limit the current through any pair of mains to 25 or 30 amperes, and as each circuit is protected by the vestry's standard fuses, kept under seal, it is immaterial whether or not any fuses exist on the branch circuits. The rule that no conductor shall be smaller than a No. 18 S.W.G., renders a 220-volt supply absolutely safe, though not a single branch cut-out existed on the whole system, because you may short circuit and blow the main 30-ampere fuse through a No. 18 S.W.G. insulated conductor without damaging it in the least. Cut-outs in ceiling roses are useless; the branch cut-outs, one on each pole, with an inch, or certainly not less than ⅜-inch of clear break, should be relied on. Double pole cut-outs should not be permitted, as they are liable to short circuit. Main cut-outs at entrance of buildings should have, by preference, 1¼ to 1½ inch of clear break. No trouble whatever has been experienced with any switches or other fittings. It is regrettable that the insurance companies still acknowledge the use of casing with the conductors kept at about an arcing distance apart. Practically, this is wrong; the conductors should be kept in close proximity; then, on the failure of the insulation, instead of an arc springing up and continuing (as I have known it to do on 115 volt circuits), a short would occur at once blowing the fuses. I am unable wholly to concur with Mr. Addenbrooke's remarks as to the effect on alternating current practice. As the most modern systems now employ a distributing network, the introduction of a higher voltage lamp would be a distinct advance for either system.

The President* said: As Manchester had been referred to, he would like to add a few words to the discussion. Of course, in Manchester, they had for two or three years had experience of high voltage, and in particular in the Town Hall, where they were actually working at 400 volts, for they took in all five wires there. According to circumstances, they burnt two to four lamps in series, and they had large groups in series for lighting public rooms. They had had no trouble whatever in connection with the wiring. Of course, they did take care not to put in the 400 volts the fuses intended for a 100-volt circuit. They had special fuses arranged for the purpose, but from the beginning they had had no trouble, and had had to make no changes. The same system existed in Manchester as in other places. They had other places where there were three wires in, and in instances of that kind they did get the actual 200 volts on the terminals. No trouble had resulted in any case, so that they might be certain so far as the wiring was concerned, that they had nothing to fear from 400 volts. The question of leakage had been referred to in connection with Manchester. It was true that from the negative terminal there was a substantial leakage, and that existed, and always would exist, because the middle wire they were bound to put to earth. That, of course, really arose from the fact that bare copper was used to a considerable extent. It was now used to a greater extent on account of the great facility it afforded for making connections and avoiding vulcanising joints. Leakage had caused them no inconvenience at all, but there was an admitted certain loss of power from that leakage. Mr. Addenbrooke had referred to the use of accumulators, and particularly to the use of accumulators at out stations, and he had pointed out that if you required to increase the capacity of a main you could do so by putting an accumulator at the end of that main and charging it. The fact really amounted to this, that comparing the out-station accumulator with the corresponding power at the station, they should compare its cost with the cost of the boiler, the engine, the dynamo, and the feeder, because they were enabled to make use of a feeder through very much longer hours; and the real fact was that they increased the radius at which they could work, and largely increased the extent to which they could use their copper. There was an additional incidental advantage in the use of out-station accumulators—they did get such great facility for regulation: they could regulate the pressure at the end of that feeder to the extent of one cell.

Mr. G. L. Addenbrooke* said it was rather a difficult matter to reply to such a very large number of points as had been raised at such a short notice; therefore he should be glad to have an opportunity of considering his remarks afterwards, and sending in his reply a little more categorically than he could make it then. In the first place, perhaps he ought to have mentioned in his paper his indebtedness to others. It was at the suggestion of Mr. Crompton that the paper was put in the form of a paper at all. His first idea was simply an article to be sent to one of the journals. But on mentioning the matter to Mr. Crompton, that gentleman said he thought it was worth a paper, and that he would like to see what he (the speaker) had written on the subject. Unfortunately the fire at his works had prevented Mr. Crompton from taking quite so much interest in the paper as he might otherwise have done; still he saw the proofs more than once, and there were some valuable suggestions in the paper which were due to him. He knew, further, that Mr. Crompton was very anxious to be there that evening to take part in the discussion, when no doubt he would have given them some very valuable hints on the subject; but unfortunately he had been called abroad. He (the author) was also indebted to Mr. Ernest Scott, his partner, who had gone through all the figures and so on; to Mr. Callender, who, of course, had prepared the table given in the paper, and to Mr. Epstein, who had taken considerable trouble in looking up contracts to ascertain the amount accumulators had come down in the last few years. There was just one point he would like to refer to, which had not been touched upon in the discussion. He mentioned in the paper a certain proportion of 8 C.P. lamps to 16 C.P. lamps, and following out some earlier experiences he had written, under the impression that the number was very considerable; but when in conversation with Mr. Swan the other day, that gentleman said he appeared to be under some misconception as to the relative numbers, as from what he could say off hand, he thought the sales of 8 C.P. lamps in the case of the Edison-Swan Company did not amount to much more than a quarter of the 16-C.P. lamps sold. That was, he thought, a very important point, because if after so many years of experience, the Edison-Swan Company, who had enjoyed almost a monopoly, had found that comparatively few 8-C.P. lamps were used, then the argument against 200 volts was weakened all the more. It was a pity that central stations would calculate all their results in 8-C.P. lamps, when they had a much more reliable basis in 16-C.P. lamps. It was no doubt a practice brought in in the early days, when central stations liked to see as many lamps as possible on their circuits; perhaps they had outgrown this feeling by this time. There was one very curious thing about this double voltage question, and that was this: Why had they not had an intermediate voltage? They were told by all the makers that they could make a 220-volt lamp. Well, the same figures would apply, certainly in a modified sense, to a 150-volt lamp. Such a lamp would, however, halve the section of mains over the 100-volt, and that in itself would be an enormous gain. It was very curious that there were no 150-volt lamps in the market, for they would be very useful for lighting factories and many other purposes. No doubt, it would be inconvenient for some central stations to change to 150 volts, yet fresh central stations were starting up every day, and in alternating stations, too, the change could be made. He believed lamps of those voltages were much more largely used on the Continent, and in Austria a good many were working at 150 volts, and 60 volts. Apparently, we were going to make a big plunge right away. At Edinburgh, Prof. Kennedy was changing the whole system to 230 volts, and the Westminster Company were offering their customers to change their lamps for 1s. 3d. each, and give them a certain guarantee if they would go over. He spoke without actual official figures, but he fancied the Brush Company had determined to light the Wandsworth Station at 220 volts, and that voltage was going to be in use at a good many other places. Mr. Shoolbred told him at the last meeting that he was carrying out the Birkenhead installation on this system, and he found the calculations come very near those in his (the speaker's) paper. There was one thing this debate had brought out at last, and that was that they had actually seen the lamp makers, and heard them speak. He did not think that since Mr. Swan brought out the lamp, they had ever heard very much from the lamp makers, and there was no doubt a great many electrical engineers had been feeling their way in the dark to a great extent with regard to this lamp question. He must say that until Mr. Robertson very kindly showed him over his lamp factory six or eight weeks before, he had never seen incandescent lamps made. However, they had really got to the other side of the question to some extent, and he could not help thinking the debate would do a great deal in telling electrical engineers what was known of incandescent lamps, and what were the difficulties. They did not want to bear hardly on the makers. If there was a difficulty the makers could not meet engineers must try to meet it on their side, but if there were things they could get over, and which would be a help to them (the engineers), no doubt it would be a great advantage to both to try and work them out. Mr. Swan had spoken about the fluctuations of voltage. That had been a sort of pet subject of his (the speaker's) for a long time. These fluctuations were very much greater than central station companies liked to acknowledge, and it was one reason why, up to the last year or two, he had been in favour of alternating currents, for it seemed to him possible with alternating currents, if they were forced to use 100 volts, to get better regulation than with a continuous current system, at any rate if the area were at all considerable. That was a good deal altered by having 200-volt lamps. From the experience he had had with 200-volt lamps, he felt sure they were a good deal less affected by slight changes of voltage. He had recently tested some oil engines which were not very steady, and they were not able to keep the voltage down. Once or twice they ran away, and the voltage went up to 300 volts. The lamps were horizontal, and although the filaments bent over and seemed half-fused, they did not give way. In one or two cases they touched the side of the lamp and soon went, but in other cases they did not, and for some time afterwards burnt in that form. He was sure Mr. Stearn's remarks would be very much appreciated. He had made this subject a speciality, and certainly the form of lamp which he had shown was exceedingly pretty; he thought, when they had had an opportunity of examining it more closely, they would see that it was a thoroughly practical form of lamp, a class of lamp, indeed, which would be very nice even with 100 volts; the light was more concentrated. A great many of the lamps shown had two filaments, and there seemed to be a sort of supposition that if they had two 8 C.P. filaments in a 16 C.P. lamp, the life of that lamp, on the average, would be about one-half what it would be if there were one. But that did not follow at all. If the average life was 800 hours, perhaps one of those filaments would go in 700 hours; it was not true that the life of the lamp was halved by having two filaments. Replying to a remark by Prof. Perry, the speaker said he did know what the cost of the lamps were, and he had given a very outside figure. His feeling in writing was to keep largely inside on every point, and he believed if he tried to stretch the thing, he could stretch it to very nearly double by adding a little here and a little there; but he thought the gain was sufficient if he took it as it stood now, and he thought there was very little that could be said against it. Mr. Geipel had spoken about the £60 a kilowatt in his estimate. He (the author) had briefly pointed out that that estimate was for a station carrying feeders 2½ miles with a network, and it assumed that the density of population was the same over the whole area; that was to say, that by far the greater number of lights, if they counted the squares round the outside on the diagram, would be at the greater length. But if they took a diagram like the one shown drawn on a piece of tracing paper to the scale of most towns in Eng-

land, in fact of any except London, and laid the map down on it, they would find they were a long way in the suburbs. Supposing they put the station half a mile out of the centre, or a mile in some cases, the cost of the main would be slightly increased, but very little, and therefore that £60 per kilowatt was in the first place a very outside figure, and at the same time enormously inside what was being done now. As regards alternating central stations in the Islington station, he was told, the cost per kilowatt amounted to £212.

Mr. Geipel: That includes some provision for extension.

Mr. Addenbrooke* said he was willing to admit that that was an outside figure, but there it was. Mr. Baynes had given some actual figures. He wished to take a very low loss, smaller than that which Mr. Baynes considered desirable, and that was an important question for consideration, if they wanted even pressure at the very small falls which all lampmakers would tell them were necessary to get the best and most economical form of lamp, they wanted more copper. The amount of copper at 250 amperes per square inch came out at a very moderate figure. Mr. Baynes, by allowing a rather greater fall, and working at greater current density, had actually got distribution over a square mile from one feeder point only with a drop of 2 per cent., and there was no doubt whatever, if they worked out a central station that way, the cost per kilowatt of mains would come down very much indeed. But there was another point in which the cost began to go up a little that way. For instance, he had taken out the cost of copper in armoured concentric cables at an ordinary figure for each size of cable, and he took out the cost of insulation and everything else. Well, he found that if they had a conductor of say a square inch section, the figures came out practically the same as those given by Mr. Callender; but when they came to a conductor of 7/18, or thereabouts, the cost of the insulation went up to something like seven or eight times the cost of copper. They had an enormously higher figure for their mains for small conductors. As he had pointed out, the cost of insulating would probably come down, and that was an additional factor in favour of adopting direct supply. But there was another point in regard to which Mr. Geipel had not quite taken his paper as it was intended. He said distinctly, after calculating out the mains and taking £60 per kilowatt, he did not consider that exactly a practical basis to argue on. It was true that was the exact basis on which an alternating supply station would be run, and he, therefore, thought it would be best to work out the calculations on this basis; but, at the same time, it was extremely doubtful whether any central station where the feeders had to go a distance would be run in future without accumulators. Mr. Geipel had spoken about loss in feeders. A paper was read before the North-East Coast Institution of Engineers, 15 months ago, by Mr. Alexander Siemens. That paper contained a comparison of the running of the Willans and Bellis engines, and excited a great deal of attention at the time, and a good deal of discussion. The facts appeared in another form in Mr. Mark Robinson's paper before this Institution. It had always seemed to him that the real gist of that paper—the great importance of it—had been entirely lost sight of and forgotten simply because it happened to contain an account of an exciting race between two engine makers. The results of those tests went to show that it was almost a case of splitting hairs to say which engine was the better; and the real gist of Mr. Siemens's paper—what he wrote it for—had been lost sight of. That paper was written to show the running of a central station. It was true the central station was established in Messrs. Siemens's works, but he had no need to tell them that those works were of very large extent. To all intents and purposes they had a central station of about 1,000 horse-power, and that station was working at a little less than a nine hours' load, the load factor being ·28, a good deal better than most stations were now run at, but a good deal worse than if they ran all day. Well, Messrs. Siemens showed the result of a six months' run of that station under ordinary working conditions. The cost of their coal was 17s. 10d. a ton, and they added the cost of labour, depreciation, and other matters. It was true the labour might not be quite so large an item as in another station, as they had skilled engineers on the spot who could attend to it. Still, with a load factor of ·28, and coal at 17s. 10d. a ton, their cost per kilowatt hour came out at a little over ½d., ·58 of a penny. What Messrs. Siemens could do, others could do. If they had a nine hours' load, they could generate their current for something in the neighbourhood of ½d. Supposing they had to charge accumulators from that, and they had 25 per cent. loss, they could still see that, allowing for that loss, the cost of the current came to very little indeed. It appeared to him if they could introduce accumulators, which their present price admitted of, they could supply current, at a very much reduced figure on its cost at present. If they could get those 200 or 220-volt lamps, and cut down the cost of their mains in such a proportion, and if they could get accumulators, and keep their voltage even, they might get quite as economical lamps, as those now in use at 100 volts and there would be an enormous gain. In reply to what some of the speakers had said in view of the great gain to the companies in using 220-volt lamps, he thought they could very well afford, where customers used them, to make a slight reduction in the cost of current, and he had shown that a reduction of one-third of a penny would really cover anything that the customer was likely to suffer from.

The meeting then terminated.

At the ordinary general meeting held at the Institution of Civil Engineers, 25, Great George Street, S.W., on Thursday evening, March 26th, the president, Dr. John Hopkinson, F.R.S., occupied the chair. The formal business having been transacted,

The President said the balance-sheet had been circulated amongst the members, and he would therefore suggest that it be taken as read. He moved that the statement of accounts and balance-sheet for the year ending December 31st, 1895, be received and adopted.

Major-General Webber seconded.

Mr. J. S. Raworth rose to propose an amendment. The president requested Mr. Raworth to be as brief as possible, as there was a paper to be read, and doubtless there were many members present who had come especially to hear that paper.

Mr. Raworth: I feel that strongly. Perhaps it would suit you, sir, to postpone this discussion on the balance-sheet, so that we might not suffer any inconvenience.

The President: We can hardly do that.

Mr. Raworth, continuing, said he had received from the secretary the balance-sheet which had been just described and taken as read, and as it was part of his duty to deal with balance-sheets, and he was therefore to a certain extent conversant with accountants methods, he had taken the trouble to cast his eye over this particular sheet and to endeavour to understand it. At the very outset he found some peculiarities which set him to work to get right down to the very bottom of it, because he thought if he succeeded in understanding it he might, perhaps, be able to render some service to the Institution by enabling the members also to understand it. As the result of those endeavours, he thought he had succeeded in thoroughly and completely understanding it. The gist of his remarks would be, in the first place commendatory, in the second place explanatory, and in the third place critical. To begin with, he found their secretary had kept the accounts of the Institution in a thoroughly admirable manner, and after he (the speaker) had constructed a balance-sheet of the accounts of the Institution as it should be constructed, he found that there was not one penny of difference, but that the balance-sheet came out absolutely correct. He was sure they would be very much gratified with that. Now, coming to the balance-sheet in detail, they would have observed one remarkable thing in connection with it, that it was the first time in their history that they had been treated to a balance-sheet. They had never had one before. [Sir David Salomons: Oh, yes, every year.] On every previous occasion it had been called an estimate of assets and liabilities; on this occasion it was called a balance-sheet, and he ventured to suggest that there was the greatest difference in the world between these two definitions. An estimate of assets and liabilities, in the view of an accountant, was quite a different thing from a balance-sheet. They looked upon him probably as an engineer, and not as a skilled accountant, and therefore having first of all submitted this balance-sheet to his friend Mr. Hodgson, accountant to the Brush Company, and next to Mr. Garcke, who stood very high in the esteem of the financial world as a skilled accountant, and got their approval of it, he took it to a gentleman who stood, he believed, in the very first rank as an accountant in the City of London. That gentleman said: "It is not very much worse than the generality of balance-sheets of these institutions. They always are lax, and I always deplore it, because in their case it is more necessary, than in the case of a mercantile company, that their balance-sheets should be on the very best lines possible, because what is everybody's business is nobody's business, and accounts are liable to get into a very bad condition." He (Mr. Raworth) got out a balance-sheet in the proper form, and it was absolutely correct. The first thing that struck him in looking over the Institution balance-sheet was a figure at the bottom right-hand corner, where they found "furniture as per last balance-sheet, less depreciation, say, £14." He looked to see if that depreciation had anywhere been provided for, and found that it had not. How they could possibly on this method of constructing a balance-sheet write off £14 of depreciation without in some other portion of it providing for that depreciation, he did not know. Then he found, looking at the item, "books, pictures, &c.," that the sum total had risen from £1,043 last year to £1,093 this year, being an accretion of £50 without any apparent expenditure on that item except the small sum of £8 2s. for books and periodicals. He thought he had shown them sufficient to make them believe that this balance-sheet had some very strange peculiarities, and the excuse he had for bringing this matter before them was that he looked on a balance-sheet—an absolutely sound balance-sheet—as the greatest security an Institution of this kind could have for the transmission of its funds and assets unimpaired to future generations. They who were now present would soon vanish from the scene, and others would take their places. The Institution of Electrical Engineers was now constituted of themselves, and some others on the list, but in a few years those names would vanish and others appear, and he thought the best legacy they could hand down to their successors was a balance-sheet sound, business-like, and perfect, because if they put the time off until they got some defalcations, how very difficult their position would be. Instead of being an easy task, as his was that night, to show up the defects of the balance-sheet, it would be a very painful operation, and one they would think which might have been tackled by their predecessors. He did not want to press this matter home that night. He did not think their Council thoroughly understood the papers they had in their hands, and if the remarks he had made did not convince them, he would proceed. The next point he had to call their attention to was a fund of which they were all very proud—he referred to the Salomons Scholarship fund. Now, in making a fresh balance-sheet out for this Institution, and coming very close on to a balance, he found he could not make the accounts balance by the sum, if he remembered rightly, of £570 13s. 6d. He had got that amount more in assets than he ought to have, and he scanned the balance-sheet from top to bottom to find out where that money had come from. If it was possible for money to get into a balance-sheet without being accounted for, it was equally possible for money to get out of a balance-sheet without being noticed. He found at last that they were indebted to Sir David Salomons for this £570 13s. 6d., and he remembered that at the general meeting which took place some months ago, it had been stated that Sir David Salomons had been so good as to give them £400: he had given them, as a matter of fact, £570 13s. 6d., and yet they had not acknowledged that in their balance-sheet in the slightest degree. Two or three years ago, when Sir David kindly gave them the first sum towards the fund, they put a note at the bottom, "presented by Sir David Salomons to the Salomons Scholarship fund";

and that, he thought, was a perfectly right and proper thing to put in, but on this occasion they had dropped that out and made no acknowledgment whatever to Sir David Salomons. Sir David did not confine his gift to mere pelf, he was a very rich man they knew, but he had given them more than money—he had given them his services. He had learnt from a member of the council—he thought he should not be betraying a confidence if he stated that Mr. Dane Sinclair had told him—that since he had been on the Council he had found that nobody gave more attention to the affairs of the Institution, or looked more strictly after the honour of the Institution, than Sir David Salomons; and yet when they came to the balance-sheet, which would be a record to future generations of how they got their money, and who were their friends in early days, there was no mention made of Sir David Salomons's gift to this Institution. From the point of view of the balance-sheet it was altogether wrong for any sum to get into that balance-sheet without any explanation as to how it got there. He thought he had said quite enough to show that this was not a satisfactory balance-sheet for the Institution of Electrical Engineers. Now to come to another benefactor of the Institution. He did not know what his name was, but he had given them four guineas to the library fund, whatever that might be, and he found, so far as he could judge from the balance-sheet, that they pocketed that four guineas, but had not done anything with it for the benefit of the library. They spent in 1895 £8 2s. on books and periodicals; in 1894, £6 19s. 8d.; in 1893, £8 18s. 7d.; and in 1892, £12 19s. 3d.; so that if their good friend thought the interests of the Institution ought to be attended to in the matter of books to the extent of four guineas, he thought they might take it he had been disappointed, and they had applied that money to some other purpose. It might be said that if he did not complain why should they, but probably he was one of those individuals who would put up with a great deal rather than make any complaint whatever. There was another matter he wanted to bring before their notice, and that was, that the funds of the Institution had gone up so successfully that their cash balance for the year was £1,173 16s. 6d., after making a provision for paying into the building fund the sum of £90 interest on building fund. He knew Sir David Salomons took great interest in this fund. He believed it was at his suggestion that was founded, and a very good suggestion it was, and he (Mr. Raworth) thought they did owe to that fund that they should deal rightly, fairly, and squarely by it Last year they spent the sum of £3,000 on it; this year they had transferred to it the sum of £500, making £3,500, and it had earned interest to the extent of £90, making it £3,590, but the fund only stood in the balance-sheet at £3,500. He did not want to use hard words, but that poor fund had been swindled out of £90 somewhere. It seemed a nice thing to have £3,000, but if there was no interest it did not get much better. It might seem a very nice thing if he were to give them an oyster bed, but if there were a proviso that they were not to have any oysters, it would not be of much use.

The President said that Mr. Raworth could shorten his remarks by doing without all this illustration, so that they could get along with the paper.

Mr. Raworth said that might be so. He thought it was a very important matter, but if they would allow him he would proceed at once.

The President: You have been already a quarter of an hour.

Mr. Raworth said this was the foundation of their business, so to speak. He wanted them to consider that they had a surplus this year of £11,737 16s. 6d., and yet they had spent on premiums on papers only the small sum of £23 3s. This Institution was founded, as they knew, for the purpose of the advancement of electrical science, and by clause 5 they were to make grants of money for books, apparatus, &c., for the purpose of promoting investigation; and yet having that surplus of £11,737, they had only spent £23 to stimulate their members, while the Institution of Civil Engineers had spent £412 9s. 6d. Sometimes it was remarked that very good papers that ought to be read before that Institution had been taken to the Civil Institution, and he thought the explanation was to be found in that particular fact. They had an enormous number of young members who had gained experience in the midst of business, which might be very valuable, and many of them would bring forward and read papers if they could afford to do so.

The President: I do really think you are diverging on to matters which have nothing to do with the question.

Mr. Raworth said that the way in which their money was spent had a great deal to do with the questions arising out of the balance-sheet. However, as the President did not wish him to continue he certainly would not. He had not wished to move the resolution he would lay before them, because he had hoped the Council would see that the leaving out of this document of important considerations reduced it below the level of what a balance-sheet of the Institution of Electrical Engineers ought to be; but he must now carry out his pre-arranged plan and move "that this balance-sheet be referred back to the Council for amendment."

Mr. W. M. Mordey: I have very great pleasure in seconding the resolution.

The President: I will ask our accountant, Mr. Biggs, to give us the explanation of the points which Mr. Raworth has raised.

Mr. Biggs said the balance-sheet, as mentioned by Mr. Raworth, showed the liabilities and assets in balance-sheet form for the first time this year. This was decided upon in consultation with Mr. Webb and the auditors last year, and, of course, 12 months had necessarily to elapse before it could possibly be done. Having largely helped to prepare this balance-sheet, he had not found much difficulty in understanding it; but gentlemen who were unacquainted with accounts might possibly find some little difficulty in understanding an ordinary balance-sheet; but if they took the assets, they would find on the right-hand side that the investments of the Institution were there set forward in full detail, and they amounted to £10,500. With regard to the item "furniture as per last balance-sheet," he was afraid that was a slip, a mistake of the secretary or the printer, because this was the first time that the balance-sheet was issued in that form. As to the £14 depreciation, Mr. Webb, in consultation with the auditors, had decided that to be quite sufficient; that reduced the furniture to £200, and Mr. Webb said there would be no necessity for any further depreciation. That £200 represented the value of the furniture now, and would probably still represent it in 10 years time. The overdue subscriptions were estimated to realise £228. A certain amount of care and attention had been paid to the list; it had been gone through carefully, and he was advised that £228 was a very fair figure to put it at. To the stock in hand of Institution journals and Ronald's catalogues, the same remark applied to the books and pictures. The Ronald's library had been mainly acquired by gift; they were not purchased, and if any half-dozen gentlemen would like to value those books, they would probably all bring out a different value. It was quite sufficient for the purposes of the Institution to put that at £1,093. Those were the assets. On the other side the different funds to which the assets belonged were set forth. There was the premium fund, the life-compositions, and he might remark that with regard to the life-compositions they must be shown separately under the articles of association, which provided that they must be so shown—the Salomons Scholarship fund, which also was shown separately because the income was shown separately, and was applicable to a certain purpose. The Institution could not divert the assets, nor could they divert the income. The building fund and the general fund comprised together £6,700, and the distinction between the two funds was a distinction made by the Council, and for which they were solely and entirely responsible. They formed the capital account of the Institution, so that the balance-sheet, boiled down as it were to nothing, showed that the assets of the Institution amounted to over £12,000. He did not know that he could give any other explanation. It seemed to him that, on the face of it, the balance-sheet gave all the information that was necessary. Mr. Raworth, as he understood it, said it was a sound balance-sheet. [Mr. Raworth: No, no.] He thought it was a very sound balance-sheet himself. He thought any Institution which could show £10,000 of assets, which could be realised to-morrow, against any liabilities to creditors of any sort whatever, could not be said to be otherwise than in a flourishing condition. As regarded the donation of £4 4s. to the library fund, he did not know the name of the donor, nor did it form part of his business to acquire the knowledge; but the £4 4s. had entered into the funds of the Institution, and that for all purposes seemed to him to be sufficient. With regard to the memorandum on the balance-sheet as to the donations from Sir David Salomons towards the Scholarship fund. It seemed to him that the balance-sheet was not the place where they should make any remarks as to the gratitude they owed to anybody with regard to any particular donation. In all probability in this case, as in most other cases, the record of the donation was entered upon the minutes, and the gratitude of the Institution was expressed there. It seemed to him that the balance-sheet had nothing to do with the gratitude of the Institution towards the donor of any particular donation.

The President: I won't waste any more of your time, but at once put to you Mr. Raworth's amendment to my resolution.

Mr. Raworth: I would like to point out that the last speaker has not replied to any of my remarks with regard to the balance-sheet, but has left my criticism entirely untouched.

The President: I will put Mr. Raworth's amendment that the balance-sheet be referred back to the Council for amendment.

Twenty-seven votes were recorded for the amendment, and sixteen against it. The President declared the amendment carried, and immediately called upon Mr. Dane Sinclair to read his paper on "Telephone Exchanges and their Working." At the conclusion of the reading of the paper, the meeting was adjourned until April 16th.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

5,779. "An improved automatic telephone switchboard specially adapted for private installations." D. McNamara. Dated March 16th.

5,794. "A new or improved manufacture of insulating material for underground electric wires, cables, or the like." P. Raoul de Fauchreux D'Humy. Dated March 16th.

5872. "An improved electric lift." J. McLaren. Dated March 17th.

5,874. "Improvements in carbon pencils for the electric arc light." T. C. Hepworth. Dated March 17th.

5,884. "Improvements in electrical switches." R. Brymer. Dated March 17th.

5,948. "Improvements in insulating joints." G. J. Carson. (Date applied for under Patents, &c., Act 1883, Sec. 103, September 23rd, 1895, being date of application in United States.) Dated March 17th.

5,951. "Improvements in the suspension of motors for electric or other cars." J. Devonshire. (Norman C. Bassett, United States.) Dated March 17th.

5,980. "Improvements in electric switches." A. J. Bomella. Dated March 17th.

6,048. "Improvements in controllers for electric motors." J. Devonshire. (W. B. Potter, United States.) Dated March 18th.

6,053. "An improvement in electric primers for firing guns." The Morris Tube Ammunition and Safety Range Co., Limited, C. Cuthbertson, and W. H. Stentiford. Dated March 18th.

6,058. "Improvements in moderating electric incandescent lamps and apparatus for that purpose." G. Bamberg. Dated March 18th.

6,069. "Improvements in the method of electrically coating wire and apparatus therefor." W. S. Rawson. Dated March 18th.

6,071. "Improvements in primary electric batteries." W. Rowbotham. Dated March 18th.

6,113. "Improved apparatus for adapting telephone line wires for fire alarm signals and similar purposes." A. G. Burrell. Dated March 19th.

6,148. "Improvements in fittings for electric lighting." H. Lea. Dated March 19th.

6,197. "A new or improved underground system of electric traction." T. E. Doyle and J. McKenny. Dated March 20th.

6,208. "Improvements in automatic electric switches." A. Ballance and E. H. Hewson. Dated March 20th.

6,216. "Improvements in and relating to the treatment of sodium and potassium chlorides by electrolysis. C. H. Parker and J. Pullman. Dated March 20th.

6,269. "Improvements in wooden and similar casings or mouldings for electric conduit wires and cables." C. J. Wightman and A. Hudson. Dated March 21st.

6,305. "Improvements in surface trolleys for electric railways." W. S. Hull. Dated March 21st.

6,306. "Improvements in electric motors." A. Greenwood. Dated March 21st.

6,329. "Improvements in apparatus for producing, storing, and applying electricity, especially applicable to the lighting and heating of railway carriages and other vehicles." E. J. Preston. Dated March 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1895.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps.)*]

2,998. "Improvements in and apparatus for the manufacture of copper, zinc, and other metal sheets, strips, or wires, electrically." The Cowper-Coles Galvanising Syndicate, Limited, and S. O. Cowper-Coles. Dated February 11th, 1895. Metal is deposited upon a cathode formed of an endless band, which is traversed through the electrolyte in proximity to the anode. The deposit is stripped off as the cathode travels, and may be cut into strips or passed through dies, or otherwise treated. 4 claims.

3,753. "Improvements in railway signals." R. C. V. Colina. Dated March 28th, 1895. An iron bar is fitted beneath one rail of the permanent way, a portion of it being prolonged beneath the rail and slotted to receive the screwed lower end of a standard reaching to the top of the rail. The slot also receives a second standard which holds the first standard tight against the rail. The bar is turned off at an angle from below the rail head and attracted to the short end of a small lever. The longer end of this lever is pivoted to the rod of a dash-pot which regulates the return action of the lever, the extremity of the lever being placed within striking distance of an electric contact so that the required signal is given. 1 claim.

3,841. "Improvements in the method of and apparatus for ventilating manholes, electric light boxes and underground chambers or cellars of all sorts." G. H. Nisbett. Dated February 22nd, 1895. The frame of the chamber is made double at portions or throughout the whole of its length, and ducts are provided leading firstly from the interior of the chamber into the channel and formed by the double frame, secondly from said channel to the space outside the manhole which is filled with a porous drainage material for the water to drain out of the channel, and, thirdly, from the channel to the outer air. The manhole is thus ventilated through the channel. 5 claims.

4,154. "Improvements in apparatus for use in electro-deposition." The Cowper-Coles Galvanising Syndicate, Ltd, and S. O. Cowper-Coles. Dated February 26th, 1895. In order that the cathodes may be brought nearer to the anodes they are hung from cross pieces which rest upon but are insulated from parallel bars or girders supporting the anodes. These parallel bars are all connected at one or both ends to one pole of the generator. 2 claims.

4,577. "Improvements in or connected with apparatus for electrically lighting miners' safety lamps." W. Ackroyd and W. Best. Dated March 4th, 1895. A box or case is divided into three compartments, one containing a Grove battery, another an induction coil, the third, for the reception of the lamp, is provided with a spring conductor in its base, and a similar contact is provided in the lead of the compartment. An electric switch is actuated by the opening and closing of the door. The lamps are provided with a conductor passing through the base and insulated therefrom projecting into the combustion chamber of the lamp. The upper conductor also makes contact with the flame of the lamp, and on closing the door the switch is operated and a number of sparks produced which light the lamp. 4 claims.

5,815. "Improvements in or relating to key mechanism for typewriters, telegraphs, and like machines." H. A. Seidenmann. Dated March 20th, 1895. The mechanism is arranged so that with a limited number of keys a large number of different movements is produced. With this object each key when pressed separately operates one movement, but when pressed in conjunction with another key operates a different movement. The total number of movements possible is equal to the number of keys, together with the combinations of this number, taken two at a time. 2 claims.

6,010. "Improved form of magnetic clutch." B. M. Drake, J. M. Gorham, and H. C. L. Holden. Dated March 22nd, 1895. The clutch consists of two main portions, one of which constitutes the electro-magnet and the other its armature, one fast to the driving shaft and the other to the driven shaft. The magnet consists of a metal disc having a coil of wire suitably wrapped upon it, so that when the current passes through this wire the magnet will be excited. A cylindrical sleeve attached to the rear end of the disc carrying two metallic rings insulated from each other and from the sleeve. These rings are connected one to each end of the wire coil and may have grooves in them so that connection may be made with the coil by means of flexible conductors bearing in the grooves connected with the source of electricity, while the disc and sleeve are revolving. Between the face of the armature and the magnet disc a thin sheet of brass is placed to prevent sticking. 2 claims.

6,177. "Improvements in alternating current dynamos." W. B. Esson. Dated March 25th, 1895. Relates to armatures which are built up of thin plates stamped out to a truncated wedge shape with tunnels near the short sides for receiving the armature coils. When building the armature, a number of the plates are assembled together enclosing a coil and forming one wedge-shaped block, and sufficient of these blocks are clamped into a frame to form a ring which constitutes the armature. 3 claims.

6,545. "An improved electric arc lamp for optical lanterns and other purposes." G. Davenport. Dated March 30th, 1895. Consists in employing two separate slotted tubes fixed to a base, and in which tubes or rods slide carrying the carbon holder. The rods are provided with toothed racks which engage pinions running in bearings fixed to the slotted tubes. These pinions are fixed to and actuated by rods so that by the turning of the rods with their pinions, the tubes or rods carrying the carbon holders may be raised or lowered independently. 4 claims.

6,630. "Improvements in automatic exchange systems and apparatus for telephonic and other electrical communication." R. J. Urquhart. (Ward Decker, U.S.A.) Dated April 1st, 1895. Each sub-station has two lines, a calling line through which currents are sent to operate the automatic switch at the central station, and a speaking line over which currents for talking or signalling by are sent. The automatic switch comprises a series of electro-magnets, one connected to each sub-station, the armatures of the magnets are combined with ratchet wheels, or the like, to give a step-by-step motion to an arm connected with the speaking line of its particular sub-station until the said arm makes contact with a bar on which the corresponding arm appropriated to the station called is normally resting. 14 claims.

6,654. "Improvements in telephonic transmitters." M. Kotyra. Dated April 1st, 1895. The invention is based on the use of granulated carbon or other suitable conducting substance. The granulated material is enclosed in a case consisting of a spiral of cylindrical or conical form. The metallic ribbon or spiral out of which the spiral is wound may have a rectangular, square, oval, or other suitable section. The spiral case is lined with some suitable and flexible insulating material. At the ends of the case metal stop ends carrying carbon blocks are fixed. In the space between the carbon blocks are placed the carbon granules. Suitable devices are provided for pressing these grains more or less together. 2 claims.

6,657. "Improvements in holders for incandescence electric lamps." G. Lyons and H. Bevis. Dated April 1st, 1895. To enable two lamps to be carried on a single holder and also to enable the lamps to be easily moved from a given circuit, to another, a base of stoneware is employed formed in two distinct parts connected by suitable means. At each end is fitted a bayonet socket or other lamp-holder. The connections from the + and − terminals of each lamp are common to both lamps. Two separate screw clips on either side forming the binding terminals. 4 claims.

6,791. "Improvements in and relating to dynamo-electric machinery." P. R. Jackson & Co., Ltd., J. S. Lewis and G. Kemp. Dated April 2nd, 1895. Relates to the following parts of dynamo-electric machinery, namely, the armature core and the spider for supporting same, the brush-holders, pedestal bearings having an automatic oil supply from a reservoir in the base, the iron parts of the machine which are cast in one piece and then divided at the proper places, the arrangements for encasing a dynamo, preventing explosions by sparks, and preventing the case from being opened when the machine is running, and lastly the bobbins or formers for field coils. 11 claims.

19,838. "Improvements in electric arc lamps." T. E. Adams. Dated October 22nd, 1895. The arc striking and regulating mechanism is operated by a magnet wound with a thick coil, the latter shunting the arc when formed. Both coils energise the magnet in the same sense, but whenever the armature of the magnet is attracted the thick coil is open circuited between two carbon contacts, the thin coil, however, exerts sufficient force to maintain the carbons apart, and also regulates the length by means of a clutch mechanism. 11 claims.